THE IRON TRADE REVIEW

VOLUME XXXIV. CLEVELAND, O., NOVEMBER 14, 1901. NUMBER 46

THE WEEK IN IRON CIRCLES.

THE MARKET AT LARGE.

No relief has come to the iron trade in the week from the stringency of the railroad embargo, which is still the dominating factor in the situation. The furnaces of the Pittsburg district, the Shenango and Mahoning Valleys and the Chicago district are most affected, a number in each of these districts being banked at this writing, for lack of coke, with the prospect that pig iron production will continue to be curtailed from 20,000 to 30,000 tons a week until the season of navigation releases cars that are now hurrying coal to lake ports. The depletion of furnace stocks goes on and there is now less than a full week's supply in the hands of makers. The conditions have conspired to make producers firmer and some Southern furnaces have advanced foundry iron 25 to 50 cents, the minimum for No. 2 being now $11.25, Birmingham, with most sellers. On the new basis the active demand keeps up and contracting steadily goes on for deliveries covering the first half of 1902. There is now very little hesitation in entering the market, consumers finding accumulating evidence that the overtaking of consumption by production is being pushed well into next year. Northern foundry irons are advancing also from 25 to 50 cents, in the face of a very general feeling, in which leading furnace interests share, that advances are not in order. Forge iron is higher under steady buying in the Valleys and Pittsburg. Interesting in this connection are the negotiations between the Republic Iron & Steel Co. and the Tennessee company by which the former proposes to contract with the furnace company for its supply of forge iron for next year apart from the output of its own furnaces. The movements on foot to regulate the price of old material are attracting some attention. A meeting of dealers has been held in Cincinnati, and Western rolling mill companies are expected to hold a conference in New York on Nov. 21. The largest pig iron contracts of the week have been for Bessemer iron, 40,000 tons being sold by the associated furnaces of the two Valleys. This was at $15.25, Valley furnace, but it is understood that smaller lots have brought $15.50. The pinch of the steel scarcity is more pronounced. It is now stated that a purchase of German billets has been made for delivery at a point west of Pittsburg, on a basis equal to $28.50, delivered. There is no interruption of rail buying, the largest order of the week, 55,000 tons, coming from the Baltimore & Ohio. It is understood that the Chicago mill has all the rails it can roll for next year—an indication that the taking up of the capacity of all the mills for 1902 is now only a matter of weeks. The plate pool at a meeting last week reaffirmed prices. The report of a plate mill consolidation has come out again, evidently having no basis further than the holding of this meeting. Bar iron has been reduced $1 a ton to Western consumers, making the basis 1.50c, Pittsburg, instead of 1.55c. This was to equalize the price with that of steel. The effect of the change has been to lead consumers to look for a further reduction.

PITTSBURG.

OFFICE OF *The Iron Trade Review*,
429 PARK BUILDING, NOV. 13 1

The car shortage continues to hamper the proper movement of freight in this district, and the situation today is no better than it has been for the past few weeks. A number of furnaces in this district have been compelled to bank for several days in the past week on account of the shortage of the coke supply, and furnaces in the Mahoning and Shenango Valleys are suffering likewise. The railroads are using all available cars to facilitate the movement of coal to the lake ports before the navigation season closes, and it will be at least ten days before these cars are again available for the shipment of coke from the Connellsville region. All the furnaces in operation are running on small supplies of coke and the slightest break in deliveries results in banking. At the present time no less than ten furnaces in this district and in the Valleys are banked on account of the shortage of coke.

Nor are the cars forthcoming for the proper movement of finished materials from the mills in this district. It is estimated that no less than 25,000 tons of finished material await shipment in the mill yards in this vicinity and every day the tonnage piled in the yards is increasing. That something radical must be done to relieve the situation is apparent to the Pittsburg manufacturers, and the railroads are being urged not only to increase their yard facilities but also to increase their rolling stock by the addition of thousands of cars. Furthermore, the manufacturers believe that they are being discriminated against in favor of other great shipping centers, where railroad interests entering this territory are having no trouble in finding sufficient rolling stock to move material. Additional trunk lines, East and West, are what the manufacturers are anxious to secure.

The iron market has been particularly active during the week, the sale of all the available Bessemer iron to be produced by furnaces in the Bessemer Association throughout the remainder of the year, amounting to 40,000 tons being the largest transaction. This sale was made on a basis of $16, Pittsburg, although small sales for immediate delivery have been made as high as $16.45 per ton, Pittsburg. Another large pig iron transaction that is now being negotiated is between the Tennessee Coal, Iron & Railroad Co. and the Republic Iron & Steel Co., whereby the latter agrees to purchase all the forge iron it requires, outside of what is made by its furnaces, through the next year. Should the negotiations go through this sale of iron will be one of the largest ever made as nearly 200,000 tons will be involved.

A scarcity of both Bessemer and open-hearth billets, sheet and tin bars continues and a shipment of billets was made by the Tennessee Coal, Iron & Railroad Co., to the Youngstown district last week. The sale was made on a basis of $28 per ton, Youngstown. An order for both billets and sheet bars has been placed during the week with German producers by local brokers. The billets are being secured at $16.50 per ton at the German seaboard, which will bring the price for delivery west of Pittsburg, their destination, to about $28.50 per ton, duty, ocean freight and overland shipment amounting to about $12.

The Baltimore & Ohio railroad placed an order this week for 55,000 tons of rails for delivery next year. The mills of the United States Steel Corporation were given 30,000 tons, while the Cambria Steel Co. will roll 15,000 tons and the Maryland Steel Co., 10,000 tons. The rail tonnage for next year is growing at a great rate and the first of the year will no doubt find orders on the books of the rail manufacturers for close to 2,000,000 tons.

last Thursday and current prices were reaffirmed. The demand for sheared plates is slightly better than it has been for some time and the American Shipbuilding Co. will shortly come into the market for nearly 5,000 tons of material which will greatly help the situation.

A slight reduction has been made in the price of iron bars for shipment to points west of Pittsburg. For Pittsburg delivery and shipments west a price of 1.50c, Pittsburg, is being made and for shipments to points east of Pittsburg the price of 1.55c continues.

PIG IRON.—The lack of cars to move coke from the Connellsville region continues to embarrass furnaces both in the Pittsburg and Valley districts. In the Mahoning Valley the Struthers, Niles, Haselton and Lowellville stacks have been compelled to shut down at intervals while the furnace of the Sharon Steel Co. at Sharon, Pa., cannot resume operations owing to its inability to secure coke. This also prevents the blowing in of one of the Shenango furnaces, recently rebuilt at Sharpsville, Pa. From time to time a number of furnaces in the Pittsburg district were also compelled to bank during the week. The demand for all kinds of iron continues strong and prices are steadily advancing all along the line. The purchase of 40,000 tons of Bessemer iron by the United States Steel Corporation for delivery in December practically cleans up all the available Bessemer throughout the remainder of the year. The price paid was $16, Pittsburg. We also note the sale of 6,000 tons of Bessemer for delivery in the first quarter of next year at $16 per ton and the sale of 500 tons of Bessemer for delivery the remainder of this month at $16.45, Pittsburg. In order to insure the continued operation of the furnaces of the Bessemer Association for more than one month at a time the United States Steel Corporation has been requested to place orders for three to four months' delivery instead of only one month as at the present time. The furnacemen contend that such a move would greatly steady the market and would enable them to operate to better advantage. It is possible that hereafter iron will be purchased in this way by the United States Steel Corporation and requirements for the first quarter of next year are already being prepared, in order that the contract can shortly be placed. Foundry irons continue strong and we note the sale of 3,000 tons for delivery next year at $15.25, Pittsburg. Small lots for delivery the remainder of this year are being closed at $15.50 per ton. The past week has also seen a phenomenal advance in the price of forge iron, owing to its scarcity. Sales of small lots for delivery the remainder of this year are reported at $14.50 to $14.75 per ton. We revise our quotations as follows:

Bessemer, Valley	$15 25 to 15 70
Bessemer, Pittsburg	16 00 to 10 45
No. 1 Foundry	15 56 to 16 00
No. 2 Foundry	15 25 to 15 50
No. 3 Foundry	14 50 to 15 00
Gray Forge, Pittsburg	14 50 to 14 75
Chilled Basic, Valley	15 00 to 15 25
Chilled Basic, Pittsburg	15 75 to 10 co

STEEL.—A novel exchange of material has been effected this week at Youngstown, O., between the Republic Iron & Steel Co. and the National Steel Co., owing to repairs that are being made at the steel plants of both companies. The Bessemer plant of the Republic Co. is off for repairs in the blooming mill and the plant of the National Steel Co. is off for general repairs. The Republic plant supplies the company's mills in the Youngstown district with billets while the National Steel Co.'s plant furnishes ingots to the Shenango Valley Steel plant, the converting department of the latter being unable to furnish enough steel to keep the mill in full operation. By the terms of the agreement the Bessemer plant will furnish ingots to the Shenango Valley plant of the National Steel Co. and in return will receive billets to run the Republic mills. Orders for billets and sheet bars have at last been placed with German manufacturers and they will be delivered in this country at their destination at about the same price as they are being held by American steel manufacturers. Bessemer billets are held at $28.50, while sheet bars command as high as $31 per ton. We note the sale of 3,500 tons of wire rods at $33 per ton. The rod market is reported somewhat stronger.

FERRO-MANGANESE.—Considerable foreign manganese continues to be sold to American consumers at $50 per ton. Domestic manganese is held at $53.50 per ton, delivered at buyer's mill.

SPELTER.—The demand for spelter continues strong and large sales have been made during the past week. We quote prime western grades at 4.25c, Pittsburg.

MUCK BAR.—Considerable muck iron is being offered, but the sales are few and small. We note the sale of 100 tons at $29.50 per ton. All pig muck is held at $29.75 to $30 per ton.

SKELP.—Demand for both iron and steel skelp is not very strong and grooved and sheared iron skelp is held at 1.85c, while steel skelp, grooved and sheared, is held at 1.75c.

RAILS AND TRACK MATERIAL.—The Baltimore & Ohio order for rails aggregating 55,000 tons was placed during the past week. The mills of the United States Steel Corporation were awarded 30,000 tons, the Cambria Steel Co., 15,000 tons and the Maryland Steel Co. 10,000 tons. The latter company will roll 100 pound rails while the remainder of the order calls for 85 pound rails. Light rails continue scarce and are in great demand. We make the following quotations: Standard sections, 50 pounds and over, in lots of 200 tons and over, $28; car lots and less than 200 tons, $30; less than car lots, $32; light rails, 8 pounds, $42; 12 pounds, $38; 16 pounds, $35; 20 pounds, $34; 25 to 40 pounds, $32. Track material: Spikes, 1.95c to 2c; track bolts, square heads, 2.40c; hexagon heads, 2.55c; fish plates, 1.50c to 1.60c.

PLATES.—The American Shipbuilding Co. is figuring on placing a large order for plates shortly which will no doubt greatly relieve the sheared plate situation. A meeting of the plate manufacturers was held in New York last week and current prices were reaffirmed. Locally nothing is known of the reported combination of Eastern plate manufacturers. Officials of the Carbon Steel Co. deny that they have been approached on the deal. We make the following quotations: Tank plate, ¼-inch thick and up to 100 inches in width, 1.60c at mill, Pittsburg; flange and boiler steel, 1.70c; marine, ordinary firebox, A. M. B. A. specifications, 1.80c; still bottom steel, 1.80c; locomotive firebox, not less than 2.10c; and it ranges in price to 3c. Plates more than 100 inches wide, 5 cents extra 100 pounds. Plates 3-16 of an inch in thickness, $1 extra; gauges Nos. 7 and 8, $3 extra; No. 9, $5 extra. These quotations are based on carload lots, with 5 cents extra a hundred pounds for less than carload lots. Terms, net cash in 30 days.

BARS.—Little new business is being placed in steel bars, but the mills are all comfortably fixed on business for future delivery. A slight reduction has been made in the price of iron bars. Hereafter common iron bars will be held at 1.50c for Pittsburg and Western delivery and 1.55c for Eastern delivery. Refined iron bars are held at 1.75c and upwards. Steel bars, Bessemer bars, 1.50c; open-hearth, 1.60c; plow beams and cultivator beams, 1.50c, net; channels, angles, zees and tees, Bessemer, under three inches, 1.60c; over 3 inches, 1.70c.

PIPES AND TUBES.—All the mills of the National Tube Co. continue to operate in full and considerable new business continues to be placed. Prices are being firmly maintained by both the combine and independents. Discounts to consumers in carload lots, Pittsburg, are as follows:

MERCHANT PIPE.

	Blk. Per cent.	Galvd. Per cent.
⅛ to ⅜ and 11 to 12 inches	61	48
½ to 10 inches	68½	56

BOILER TUBES.

Steel.

	Per cent.
1 to 1¾ inches	47½
2¼ to 5 inches	65½
1¾ to 2¼ and 6 to 13 inches	60

Iron.

	Per cent.
1 to 1¾ and 2¼ inches	43½
1¾ to 2¼ inches	43
2¼ to 13 inches	53

CASING.

	S. and S. Per cent.
2 to 3 inches	58
3¼ to 4 inches	63
4¼ to 12¾ inches	65

Discounts to jobbers range from 2½ to 5 per cent below the above.

SHEETS.—Deliveries of both the heavier and light gauges are not much better than they have been during the past month and the large amount of new business that is being placed is fairly swamping both the American Sheet Steel Co. and independent manufacturers. For delivery to the first of the year independent manufacturers are quoting 3.25c for No.

28 gauge, while prompt shipment of desirable widths from warehouse stocks are held as high as 3.50c. The following quotations to the trade are made by American Sheet Steel Co. distributers: Blue annealed sheets, Nos. 10, 11 and 12, 2.40c; Nos. 14 and 15, 2.50c; Nos. 16 and 17, 2.60c. One pass through cold rolls: Nos. 18, 19, 20 and 21, 2.50c; Nos. 22, 23 and 24, 2.80c; Nos. 25 and 26, 2.90c; No. 27, 3c; No. 28, 3.10c; No. 29, 3.25c; No. 30, 3.35c. On lots less than 500 bundles the American Sheet Steel Co. does not make shipments except through jobbers. Galvanized sheets are quoted at 70 and 10 off; galvanized sheets for spot shipment, at 70 off. Prices to jobbers are somewhat lower than the above.

STRUCTURAL MATERIAL.—During the week a large number of independent structural concerns have been placing contracts for their requirements through the first half of next year and all the structural mills are filled up to next March. Plans for a new bridge for the Union Steel Co. at Donora, Pa., are being prepared and about 4,000 tons of structural material will be required. The contract for another Pittsburg office building has been placed during the week. The structural steel has not yet been placed, but it is stated that about 7,000 tons will be required. There will be no change in the price of structural material this year, although a slight advance may come early next year. We make the following quotations: Beams and channels, 3 to 15 inches, 1.60c; 18 to 24 inches, 1.70c; tees, 1.65c; zees, 1.60c; angles, from 3 to 6 inches, 1.60c; universal mill plates, 1.60c.

WIRE AND WIRE NAILS.—Both the combine and independent manufacturers of wire nails continue to make concessions to the trade amounting to 10 to 15 cents per keg. We quote single carloads of wire nails to jobbers at $2.15 to $2.20 and less than carload lots at $2.25 to $2.30; plain wire, carload lots, is quoted at $2.25 to jobbers and $2.35 to retailers; painted barb wire, $2.60 in carload lots to jobbers, and $2.70 to retailers; galvanized barb wire, $2.85 to $2.90 in carload lots to jobbers, and $3 to retailers. Cut nails are quoted at $2.05, Pittsburg, in carload lots, and $2.10 to $2.15 in less than carload lots, 2 per cent off in 10 days.

MERCHANT STEEL.—Contracts for crucible steel for delivery next year continue to be made and the outlook for next year's business is good. We make the following quotations: Turned, cold rolled and ground shafting is quoted at 60 per cent off for car lots and 55 per cent off for less than car lots; tire steel in carload lots and over, 1.60c; less than carload lots, 1.75c to 1.80c. Toe calk is sold at 1.70c, in large lots, and in small lots as high as 1.85c. Tool steel is held at 7c and upwards, according to quantity.

OLD MATERIAL.—A meeting of the largest dealers in old material was held in Cincinnati last week for the purpose of establishing a price agreement on old material. As yet no decision has been reached. No doubt this movement has been decided upon to counteract the combination of the large consumers of old material, as noted in our last issue, a meeting for this purpose having been called for Nov. 21 at New York. Demand for old material is good and we revise quotations, gross tons, as follows: Heavy melting stock, $16.50 to $17; low phosphorus melting stock, $18 to $18.50; steel rails, $17 to $17.25; busheling scrap, $13 to $14; No. 1 wrought, $17 to $17.25; iron rails, $21 to $21.25; cast borings, $8.25 to $8.50; cast scrap, $14 to $14.25.

COKE.—Owing to the scarcity of cars a large amount of coke is being piled at the ovens in the Connellsville region. Production, however, continues to keep up. For the week ending Nov. 2 the production of the region amounted to 233,720 tons, a slight increase over the production of the previous week. Inquiries for coke for delivery the first half of next year are already being received and prices will be from 25 to 50 cents higher per ton than they were last July when contracts for the second half of this year were closed. Connellsville furnace coke is held at $1.90 to $2 per ton and foundry at $2.25 to $2.50. Outside furnace coke is quoted at $1.75 and foundry at $2 to $2.15.

CHICAGO.

OFFICE OF *The Iron Trade Review*,
634 MONADNOCK BLOCK, NOV. 12

Two local furnaces have been compelled to bank their fires owing to their coke supply having been shut off by the shortage of cars, and the new Iroquois stack is still cold for the same reason. This car scarcity is really the most alarming feature of the market in this district, and is felt by shippers of finished iron and steel equally with pig iron and coke dealers. No remedy seems to be in sight, railroad agents asserting that had they more cars, it would be well nigh impossible to handle more traffic than is being carried over their respective lines at the present time. This inability of railroads to meet existing trade conditions is making itself felt in the fact that many buyers have come into the market of late with larger orders than otherwise would have been the case, in the hope that they can get sufficient stock in their yards and warehouses to prevent them being caught should the shortage of cars grow more pronounced. This is true not only in pig iron and coke, but in all lines of finished product. Most of the buying that has been done during the past week has come from the general trade, and though brisk enough it has been devoid of any noteworthy transactions.

Last week the Western Bar Iron Association, a pool composed of all the bar iron manufacturers west of Pittsburg, excepting the National Rolling Mill Co., of Hartford City, Ind., and the Hirsch Rolling Mill Co., of St. Louis, Mo., announced a cut of $1 a ton in the price of bar iron, for both prompt and long time delivery, making the price equal to that of steel bars, 1.65c, Chicago. This cut was not made, it is stated, because of any difficulty to get business at 1.70c, but to offset in a measure the deflection of business to manufacturers of steel bars, owing to the higher price of iron. The buying in bars has been light during the past week, the change in price having had the effect of inducing many consumers to withhold placing orders in the hope that further reduction may be made.

Transactions in Northern pig iron have fallen off somewhat since our last report, with a corresponding increase in the sales of Southern Iron. Orders for above 1,000 tons have been very scarce, the buying coming from the general trade and varying from 1,000 tons down to carload lots. The aggregate tonnage is exceptionally good, and, as indicated elsewhere, the biggest proportion of it has gone to Southern furnaces. Prices of both Northern and Southern iron are very firm, and there is considerable talk of an increase of 50 cents a ton in the price of all Southern grades. Already some furnaces have advanced prices 25 cents, but this is not general. Northern iron for delivery in the first six months of next year is scarce, and this is true, also, of some Southern grades. One seller of Southern No. 4 foundry has sold its entire capacity up to next July, and this same company states that its capacity on gray forge iron is taken up to next March. The buying of plates has revived somewhat, the local interest reporting orders aggregating 2,000 tons. There is no change in the structural steel situation, mills being 60 to 90 days behind in deliveries. The Lake Shore & Michigan Southern has let contracts for the construction of its freight warehouse, which will require about 300 tons of steel, and a local builder has received the contract for the erection of a building in Birmingham, Ala., requiring 900 tons of steel. Scrap iron continues weak, and prices are uncertain. The bar iron manufacturers' association is taking steps to fix the price of scrap iron, though no official prices have been announced as yet.

PIG IRON.—The market has been devoid of anything noteworthy during the past week. There has been a steady run of orders, varying from 1,000 tons down to carload lots. The scarcity of cars continues to hamper both buyers and sellers, and it is noted that many consumers are coming into the market for larger lots than would have been the case had the scarcity of cars not been so pronounced. This shortage of cars grows more alarming each week. Two local furnaces have been compelled to bank, and this has materially reduced the output of local iron. Transactions in Northern iron have fallen off since our last report, most of the tonnage being booked by Southern furnaces. There is much talk of advance of 50 cents a ton in all grades of Southern iron being put into effect this week. The strength of Southern irons may be taken from the report of one seller, who states that they are sold up on No. 4 foundry till July, 1902, on gray forge to next March, and on other grades for varying periods in the

next year. All quotations are made subject to change should the increase go into effect. We quote:

Lake Sup. Charcoal	$17 50 to $18 00	Southern Coke No. 4	$13 65 to $13 90
Local Coke Fdy. No. 1	15 50 to 16 00	Southern No. 1 Soft	15 15 to 15 40
Local Coke Fdy. No. 2	15 00 to 15 50	Southern No. 2 Soft	14 65 to 14 90
Local Coke Fdy. No. 3	14 50 to 15 00	Southern Silveries	15 40 to 15 60
Local Scotch Fdy. No. 1	15 50 to 16 00	Jackson Co. Silveries	17 00 to 17 50
Local Scotch Fdy. No. 2	15 00 to 15 50	Ohio Strong Softeners	16 50 to 17 00
Local Scotch Fdy. No. 3	14 50 to 15 00	Alabama Car Wheel	20 50 to 21 00
Southern Coke No. 1	15 15 to 15 40	Malleable Bessemer	15 50 to 16 00
Southern Coke No. 2	14 65 to 14 90	Coke Bessemer	17 50 to 18 50
Southern Coke No. 3	14 15 to 14 40		

Bars.—The Western Bar Iron Association, comprising all the manufacturers of bar iron west of Pittsburg, with the exception of two who declined to enter the pool, announce a cut in the price of $1 a ton, making the price equal to that of steel bars, 1.65c, Chicago. While the buying of steel bars has been as good as heretofore, transactions in bar iron have fallen off, which may be said to be due to the uncertainty in the minds of consumers that the present price will be maintained. We quote steel bars for immediate shipment, 1.65c to 1.70c, Chicago, and iron, 1.65c. Out of store, steel and iron, 2c; on contracts for large lots and extended deliveries, steel, 1.65c, and iron, 1.65c.

Sheets.—There is little change in the buying of this material to be noted in this city. The tonnage placed with mills has been heavy, though it is still impossible to get delivery on new business within three months. Transactions with jobbers have also been large, the delivery question turning much business to them. We quote No. 27 black, 3.75c to 3.90c, and galvanized 65 per cent and 10 per cent to 70 per cent from store.

Billets.—There is a moderate demand for billets in this market, though manufacturers have very little to offer for sale. We quote Bessemer billets, $31 to $33, and open-hearth, $33 to $35.

Structural Steel.—While the mills are all crowded with orders for structural steel, it is especially difficult to obtain angles or smaller size beams and channels, short of three to four months' time. Beams and channel of larger sizes can be furnished more promptly. A continued good business is reported, the Lake Shore & Michigan Southern having let contracts for the construction of its freight warehouse, requiring 300 tons of steel, and a local contractor having secured the contract for a building in Birmingham, Ala., requiring 900 tons of steel. We quote mill shipments, carload lots, as follows: Beams, 15 inches and under, 1.70c; 18 inches and over, 1.85c; angles, 1.75c to 1.80c; plates, 1.75c, base; tees, 1.80c; zees, 1.75c; small lots from store, ¼c higher; beams and channels from store, ½c to ¾c per pound higher.

Rails and Track Supplies.—Further large contracts are reported from Western roads, with a heavy inquiry and many contracts still pending. Track supplies are also in great demand, mills being unable to promise delivery within three months. We quote as follows: Standard rails, $28; light sections, $31 to $33, according to size; out of store, $40 to $44; splice bars, 1.60c to 1.70c; spikes, 1.90c to 2c; out of store, 2c; track bolts, hexagon nuts, 2.80c to 2.90c; out of store, 2.90c to 3c; square nuts, 2.65c to 2.75c; out of store, 2.75c to 2.85c.

Merchant Steel.—Considerable business and a good inquiry is reported, notwithstanding the fact that mills are not in any position to accept further tonnage in view of presen contracts. Our quotations for mill shipments, Chicago delivery, follow: Smooth finished tire steel, 1.90c to 2c; open-hearth spring steel, 2.50c to 2.75c; toe calk, 2.40c to 2.60c; sleigh shoe, 1.85c to 1.90c; cutter shoe, 2.40c to 2.60c; ordinary tool steel, 6c to 7c; specials, 13c and upwards. Cold-rolled shafting carload lots, 55 per cent; less than carload lots, 50 per cent.

Merchant Pipe and Boiler Tubes.—Small orders are fairly numerous, aggregating a respectable tonnage. Mills are catching up on deliveries, and report they hope to have books clear with the opening of the season. Our quotations follow:

MERCHANT PIPE, RANDOM LENGTHS.

	Black Per cent.	Galv. Per cent
⅛ to ⅜ and 11 to 12 in.	59.5	46.5
½ to 10 inches	67	54.5

BOILER TUBES.

	Steel Per cent.	Iron Per Cent.
1 to 1½ in.	40	35
1¾ to 2½ in.	45	40
2¾ to 5 in.	55	50
6 in. and larger	45	40

Plates.—Buying is much improved, the local interests reporting orders aggregating 2,000 tons. Jobbers also note an improvement in plate transactions. Our quotations follow: Tank steel, base, ¼-inch, 1.75c; flange steel, 1.90c to 2c; marine steel, 1.95c; firebox steel, ordinary, 2c to 2.10c; special, 2.25c and upwards. Tank steel from store, 2c to 2.20c; flange steel from store, 2.25c.

Wire and Wire Nails.—The local interest is experiencing much difficulty in meeting the demands of its customers owing to the shortage of cars. There is no decrease in the demand for nails and all kinds of wire products, which continues phenomenal. Independent manufacturers are reported as shading prices in order to get business in this territory. Jobbers continue to deluge the leading producer with telegrams and letters for the shipment of goods. We quote carloads of wire nails to jobbers, $2.40, Chicago; to retailers, $2.50; plain wire, carload lots to jobbers, $2.35; to retailers, $2.45; painted barb wire to jobbers, carloads, $2.70; to retailers, $2.80; galvanized barb wire, carloads to jobbers, $3; to retailers, $3.10.

Old Material.—Members of the Western Bar Iron Association announce unofficially that that organization intends to take up in the near future the matter of regulating the price of scrap iron. This subject has already been discussed at the several meetings held, though no definite steps have been taken as yet. The market during the past week has been weak, and prices fluctuate. We quote as follows:

Old iron rails	$21 00 to $21 50	Old Wheels	$15 00 to $15 50
Old steel rails, long	18 00 to 18 50	Heavy melting steel	13 50 to 14 25
Old steel rails, mixed	13 50 to 14 50	Mixed country steel	10 50 to 11 00
Relaying rails	24 00 to 25 00		

The following are selling prices per net ton:

No. 1 R. R. wrought	$16 25 to $16 75	Iron axles	$21 50 to $21 50
No. 2 R. R. wrought	13 50 to 13 75	Cast borings	4 50 to 5 00
Dealers' forge	13 00 to 13 50	Wrought turnings	10 50 to 11 00
No. 1 busheling	11 50 to 12 00	Iron axle turnings	12 00 to 12 50
Heavy cast	11 00 to 11 50	Steel axle turnings	10 50 to 11 50
Railway malleable	12 00 to 12 50	Stove plates	8 50 to 9 00
Country malleable	11 00 to 11 50	Old iron splice bars	16 50 to 16 75

CLEVELAND

Office of *The Iron Trade Review*,
1064 Rose Building, Nov. 13.

Two small blocks of iron ore have been offered on the local market for the last two days upon which the shippers were willing to pay $1.25 from Duluth to Ohio ports. The tonnage would aggregate about 20,000 tons, but the vessel room has not yet been found for them. The owners have been talking of stability in rates and it is hardly possible that the rates are a consideration in the delay in closing for this movement. Aside from these two blocks of ore that which is yet to be moved down the lake does not aggregate any large amount of tonnage and the wild chartering for the remainder of the year is expected to be comparatively light. The United States Steel Corporation has withdrawn from the market as a bidder for tonnage and with it two or three of the smaller shippers. The figures which have been compiled showing ore shipments in October indicate very clearly the possibility of a total shipment for the year of upwards of 20,000,000 tons. The October movement from the upper lake ports was 2,986,468 tons as against 2,402,887 tons for October, 1900, an increase of 583,581 tons. The total movement from the opening of the season of navigation to Nov. 1 was 18,143,573 tons, while that for the same period in 1900 was 17,287,952 tons, an increase for this season of 855,621 tons.

Pig Iron.—The market during the past few weeks has shown such persistent strength and the supply of iron available has decreased so steadily that the producers now ask an advance, and $14.50 for No. 2 in the valleys is the best that can be done for delivery in the next three months. At the same time the announcement is made of an increase in the price of Southern foundry to $11.25 Birmingham, to which is added the $4.70 freight rate to make up the Cleveland quotation. In the foundry trade the demand for material is quite heavy and the buying is only limited by the supply of iron and the possibilities of deliveries. Practically all the available material has been sold up to the first of the year and contracts have been taken which require deliveries during the first half of next year. Complaints of slowness in making deliveries are frequent and the furnaces are being importuned more strongly than ever. The latter are helpless, however;

the iron is in stock, but cars are lacking to move it. A further investigation also shows that should the cars be afforded there is a lack of both motive power and track room to handle the business that would be presented to the railroads. A basic producing furnace was banked last Saturday because of the scarcity of coke and it is not expected that it will be blown in before the middle of December, especially as this is to be made the occasion for repairs. On basic $15 in the Valley is now the lowest quotation heard. All the material available has been sold up until January 1 and the buyers have not come upon the market beyond that time, although some contracts are still pending for small sized lots. It is now common report that all of the furnaces in the Valleys will have to shut down at one time or another before the coke supply is increased which is not looked for before the close of navigation. With the recent purchases of Bessemer iron the supply for delivery in the remainder of the year is exhausted and the buyers are not disposed to enter contracts for next year. A nominal quotation of from $15.25 to $15.50 in the Valleys is still made. We quote the Cleveland market:

Bessemer	$16 00	Valley Scotch No. 1	$15 00 to $15 25
No. 1 Strong F'dry	15 00 to 15 25	Valley Scotch No. 2	14 75
No. 2 Strong F'dry	14 75	Gray forge, Valley	13 50 to 13 60
No. 3 Foundry	14 25 to 14 50	LakeSuperior charc'l	17 00 to 17 50

FINISHED MATERIAL.—The mills are now being harassed by the car shortage and the necessity of excuses to buyers is ever present. The one satisfaction taken by the producers is that the apparent necessity for better railroad facilities is sure to lead to a heavy buying of steel both in rails and in cars and engines. The demands from the steel car concerns have already increased the interest in the plate market and this wears a better aspect this week than it has during the fall. All of the reports now are that even in sheared plates the outlook is most encouraging for a good business ahead. The prospective buying by car companies and by shipbuilding companies is very attractive now. The demand for structural material has continued abnormally large for this period of the year and it has gone to such lengths that many buyers finding deliveries impossible, especially on angles, before the first of the year are already contracting ahead. Four contracts placed this week require deliveries up to the first of April next year. The rail trade has also kept up well and during the last few days a local company, which is to build a line of railroad in the Indian Territory, came upon the market and bid for 7,000 tons of rails which will likely be closed for in a day or so. In addition the needs of the lines in this territory have by no means been supplied and the tonnage is constantly increasing in volume which must be produced during the first few months of next year. The price holds at $28 with hardly a prospect of a change. A readjustment of the bar iron prices was made during the week by the Western Bar Iron Association. Both bar iron and bar steel are bringing the same price now, 1.50c, based upon Pittsburg. This is a reduction of $1 a ton on bar iron for the Western trade, due chiefly to a desire to equalize prices. It is admitted, however, that the market is not particularly strong, a condition not unnatural when it is known that the Duquesne mill of the Carnegie Steel Co. has developed a capacity of 400 tons per day. The demand for billets and sheet bars can hardly be determined because neither material is on the market. Sheets are firm at former prices, which are as follows: No. 12 blue annealed, from 2.35c to 2.40c; No. 16, 2.60c; No. 22-24, one pass through cold rolls, 2.80c; No. 27, 3c; No. 28, 3.10c.

OLD MATERIAL.—The demand for scrap has fallen off a great deal and the dealers are unable to understand the extraordinary activity in pig iron and finished steel, while their market shows weakness so plainly. A reduction in prices is generally expected to follow presently. Quotations are as follows, all for gross tons:

Old steel rails, rolling mill lengths	$17 00 to 18 00
Old steel rails, short lengths	16 50 to 16 75
Iron rails	21 00 to 22 00
No. 1. railroad wrought	16 50 to 17 00
Mill scrap	14 50 to 15 50
No. 1. machine scrap	14 00
Cast borings	7 50 to 8 00
Grate bars	9 00
Sheet iron	9 00 to 9 50
Stove plate	9 75 to 10 00
Car wheels	15 00

CINCINNATI.

Nov. 12

While the demand for finished material, as is usual at this time of the year, has dropped off somewhat, the demand for pig iron continues very heavy. The purchases of material that is to go into immediate use, or to be delivered as soon as possible, have been curtailed somewhat, save where absolutely needed, while the making of contracts and the giving of orders for raw material to be delivered on into next year can be put down as of the very best. There is every element of encouragement in this and an indication that conditions will remain very satisfactory, since it shows that while the general business is swayed by seasons and by closing of fiscal and calendar years and all that, the consumers of iron have faith in the ability of the market to sustain itself for many months to come. All manufacturing lines are still exceedingly busy. Many of the machinery concerns are promising delivery only a good many weeks ahead and are running hard to catch up with their orders. Several of the branches of one of the large industrial combinations, one of which is in Cincinnati, have business enough on their books to keep them running two years at an ordinary rate if no more orders were booked.

The consumers of finished material argue apparently that if they were to order now they could not expect delivery until after the new year, and they are of the opinion that it will be just as well to hold off a little while. The best indication of the general prosperous condition lies in the additions and increases being made by a great many of the manufacturing concerns.

PIG IRON.—During the week an advance in prices of nearly all grades of foundry iron has been asked, there being but one or two Southern furnaces of importance that quote iron at the minimum of a week ago. If, as is expected, the statement of stocks on hand will show a farther decrease, the belief is expressed that there will be another firming up that will result in an advance of 50 cents a ton over minimum prices. The same complaint of car shortage is heard and no relief has been afforded the furnaces that have been compelled to bank. The demand during the past week has been steady and well distributed. Gray forge and No. 4 Southern have been very active, while pipe works, agricultural implement concerns, jobbing foundries and the like have been generous buyers. A number of the officials of the United States Cast Iron Pipe & Foundry Co. were in the city today and it is understood that a large lot of iron was bought. This company has more business than it has had in a long time and has orders enough to keep the various branches running for a good many months. There have been few large orders placed, the bulk of the business being for car loads to 500 tons. There were orders placed for two 2,000-ton lots and one 3,000-ton lot, all of Southern foundry. Prices are quoted as follows f. o. b. Cincinnati:

Southern Fdy. No. 1	$14 00 to $14 50	Gray Forge	12 50 to 12 75
" " 2	13 50 to 14 00	Northern Fdy. No. 1	$15 50 to $16 00
" " 3	13 00 to 13 50	" " 2	15 00 to 15 50
" " 4	12 50 to 13 00	Charcoal C. W. iron	17 75 to 18 25
So. Fdy. No. 1 soft	14 00 to 14 50	Malleable coke iron	15 25 to 15 50
So Fdy. No. 2 soft	13 50 to 14 00		

It is generally expected that the minimum prices will be advanced.

FINISHED MATERIAL.—The reduction of the price of iron bars to 1.50c, Pittsburg, has apparently had no effect on the market here. Buying has been good, but has shown the tendency to ease up a little on the approach of the end of the season. There was apparently no complaint about paying the price that was being asked for iron bars before, so the reduction seems not to have had the effect of stimulating buying. Material wanted right away is bought out of store and a premium paid where necessary. Deliveries are still unsatisfactory on sheets. Prices are quoted as follows: Iron bars, 1.62c, car load lots; steel bars, 1.62c, car load lots; angles, 2c; plates, 1.85c to 1.90c; sheets, No. 28, 3.35c to 3.40c, and 3.80c out of store; sheets, No. 12, blue annealed, 2.35c.

OLD MATERIAL.—There has been no particular feature in the scrap market. Prices are firm and the demand is good. There is some amount of machine and foundry scrap coming on the market. Prices remain the same:

Old No. 1 Wrought Railroad	$ 15 25 to 15 50
Cast Machine and Foundry	12 50 to 12 75
Old Iron Rails	20 00 to 20 50
Old Steel Rails	14 75 to 15 25
Old Short Lengths	13 75 to 14 00
Old Iron Axles	20 25 to 20 75
Old Iron Car Wheels	16 00 to 16 25
Stove Plates	9 75 to 10 00
Wrought Turnings, net tons	11 25 to 11 75
Cast Borings, net tons	5 50 to 6 00

THE IRON TRADE REVIEW

Devoted to the Machinery, Metal-Working and Foundry Trades, and Iron and Steel Manufacture.

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NOVEMBER 14, 1901.

A SPECIAL ENGINEERING EDITION.

In its Engineering Special Edition of today *The Iron Trade Review* has purposed to give some idea of the achievements of the engineer in our marvelous iron and steel development. The record is an enviable one. Like every other story of American progress it involves small beginnings, painful growth in early stages and a later development of such proportions as to suggest magic rather than reality. Just as the 19th century is credited with a larger contribution to human advancement than all the centuries preceding, it is within bounds to say that the generation of engineers in the American iron industry who have made the history of the past 25 years have done more to put American practice in the forefront than all who preceded them. Concrete testimony to the fact will be found in a variety of forms in the contributions to the pages of this issue.

To say that 10,082,905 tons of Bessemer and open-hearth steel were produced in the United States in 1900, while in 1876 the output was but 488,827 tons, of which open-hearth steel contributed but 19,188 tons; or that more than 20,000,000 tons of iron ore will be moved from the Lake Superior region in 1901, where as in 1876 when 992,764 tons were brought down the ore trade was consumed with fear lest it prove a drug on the market; or that the pig iron output in the United States in 1901 will easily exceed 15,500,000 gross tons, while 1876 shows but 1,868,961 tons—these are but ways of saying that with our splendid natural resources the mechanical and the metallurgical engineer have more nearly succeeded in the United States than in any other country in eliminating hand labor from iron manufacture and in making the discoveries in chemistry and physics effective in smelting and rolling processes.

The articles elsewhere give some leaves from the records of the past 25 years. The aim has been not only to show what American engineers have done in the iron industry, but also to give some idea of the sort of men that have done the work. We have not attempted to trace the careers of all who have contributed to the quarter century's advance, but such as are sketched are representative. It is interesting to note that most of our successful iron and steel engineers, like many who have come up in other fields of endeavor, started with little capital save industry, energy and a determination to get up. A second fact that will not be missed is the youth of the men who are making history today in iron and steel manufacture. A third is the facility with which the men whose records we present have detached themselves from one company to form new connections offering a larger scope to their abilities. The mobility of engineering talent in the building up of the American iron industry is one of its conspicuous characteristics. A fourth fact is the increasing prominence given in recent years, and particularly since the formation of the consolidations, to the operating and engineering staffs of the leading steel companies. This policy, first prominently exemplified in the Carnegie Steel Co., is being carried still further in the United States Steel Corporation. It stamps the present as distinctly the day of the engineer in the iron industry, and puts an estimate upon his services that warrants large expectations for the future.

THE FOUNDRYMEN'S ASSOCIATION.

The annual meeting of the Foundrymen's Association was held at the Manufacturers' Club in Philadelphia, on Wednesday evening, Nov. 6, the president, Thos. I. Rankin, occupying the chair. There was a good attendance. The secretary announced that the report of the committee having in hand the incorporation of the association would not be forthcoming until the December meeting.

The officers for the ensuing year nominated at the last meeting were, on motion of Mr. Devlin, elected in a body, the ballot under the motion being cast by Mr. Wanner. The officers elected are as follows:

President, Thomas I. Rankin, Abram Cox Stove Co., Philadelphia.

Vice-President, James S. Stirling, Harlan & Hollingsworth Co., Wilmington, Del.

Treasurer, Josiah Thompson, J. Thompson & Co., Philadelphia.

Secretary, Howard Evans, J. W. Paxson Co., Philadelphia.

Executive Committee—Antonio C. Pessano, Chairman, George V. Cresson Co., Philadelphia; Stanley G. Flagg, Jr., Stanley G. Flagg & Co., Philadelphia; E. E. Brown, E. E. Brown & Co., Philadelphia; John Glover, Glover Bros., Philadelphia; William Hanson, Penna. Iron Works Co., Philadelphia, with the president and secretary, ex-officio.

The following were elected to membership in the association: L. R. LeMoine, of the United States Cast Iron Pipe & Foundry Co., and O. J. Ward, of the Howe Scale Co.

H. M. Baldwin, of the Power Specialty Co., New York City, addressed the meeting, his subject being "The Bryan Vacuum Molding Machine." He said in part: "Although it had been arranged that I should read a paper before you this evening, a description of the Bryan vacuum molding machine, I have thought it best to set up a machine in this room and show it in operation, the information and experience thus resulting being more interesting than a mere paper description. The machine was designed by a man of 25 years' experience in the foundry business, with a view to cheapening his foundry products. He tells me that in his foundry they are doing with this machine and two unskilled laborers work which formerly required nine skilled men. The only expense attaching to the use of the machine is that incurred in mounting the patterns on boards, and this expense, as you will readily see, is trivial in comparison to the cost of metal pat-

terns. It does away with stripping plates entirely, and an unskilled laborer can do much better work with it than a skilled workman without it. Each pattern is mounted separately and is not attached to the machine in any way, therefore no time is lost in changing patterns."

Mr. Baldwin then explained and operated the machine, which has already been illustrated in these columns. It consists of a rigid frame work, swinging on a vertical post, or attached to a wall with a movable bar or rod, having at its lower end a sucker head, which attaches itself to a pattern board through the medium of a vacuum pump, the vacuum being obtained by the opening of a three-way cock during the descent of the sucker rod. The pattern is lifted by affixed counterweights to a point where the vacuum is broken and the pattern released. Lifting could also be accomplished by the use of compressed air instead of counterweights. Jarring of the pattern is effected by means of a pneumatic vibrator, or if preferred by a mallet.

Mr. Baldwin stated that all so-called molding machines were but pattern drawing devices, and in the Bryan machine was to be found a device that would lift patterns from sand molds without expensive additions to patterns and leave the molds as near as possible to the shape of the patterns. Expensive metal patterns, stripping plates, pattern plates, backing plates, and stool plates, more or less used on draw plate machines were, it was explained, unnecessary; nor need the machine be confined to any one size of patterns and flasks. If desired, however, stripping plates could, of course, be used. Molds should be made in the usual way, either hand-rammed or pressed by a power driven press, the machine merely drawing the patterns.

Asked by Mr. Devlin whether it would be suitable for use on a cylinder mold, say 12 inches diameter, open at one end, and 15 inches deep, Mr. Baldwin replied that any pattern which could be drawn by hand on a bench could be drawn on the machine.

Treasurer Josiah Thompson presented a report showing a substantial balance in hand, and all bills paid.

H. O. Evans then read extracts from a paper by Wm. D. Allen, of Huntsville, Ala., on "Controlling Contraction of Metals While Casting, with Especial Reference to the Lower Fusing Metals." There was no discussion on the paper.

Under the head of New Business, Mr. Devlin called the attention of the meeting to the reciprocity convention to be held in Washington Nov. 19. He said: "Almost all commercial bodies are appointing representatives to attend that convention, and it seems to me it would be only proper for the Foundrymen's Association to send delegates. As there will be none but manufacturers there it will be necessary to appoint manufacturers. I therefore move that a committee be appointed by the chair to represent this association. Organizations with memberships of 100 or less are entitled to appoint five delegates and five alternates."

Mr. Stirling—How shall that committee be advised to act?

The Chairman—That is in the judgment of the committee.

Mr. Devlin—Of course, the committee should in some way voice the sentiments of the association, and no man can express his opinion here as to whether he is in favor of reciprocity or not.

Mr. Stirling—That is just what I wanted to bring out.

Mr. Devlin—A further object is to prevent any tinkering with the tariff. Terms should be made in regard to exporting agreeable to the interests of this country.

Mr. Stirling—As an amendment to Mr. Devlin's motion I will move that this association as a body does believe in reciprocity.

Mr. Wanner—Make it, that reciprocity should be the policy of this country.

Mr. Stirling—That is quite agreeable to me.

The amendment with the original motion was then put to the meeting and carried. The committee was subsequently appointed as follows: Thos. I. Rankin, R. C. Oliphant, J. K. Bongher, J. S. Stirling and A. C. Pessano.

The meeting then adjourned.

The Columbia Iron Works of Port Huron, Mich., has been incorporated with $100,000 capital.

A DISTRIBUTION TO CARNEGIE STEEL CO. EMPLOYES.

During the past week deserving employes of the Edgar Thomson, Duquesne and Homestead plants of the Carnegie Steel Co. of Pittsburg, Pa., were awarded United States Steel Corporation bonds and stock in sums varying from $25,000 to $100,000 for faithful services rendered. The fund from which these amounts were given was established some time before the Carnegie Steel Co. was absorbed by the United States Steel Corporation. The fund was established by setting aside 2 per cent of the stock of the company as an endowment, the dividends to be used in purchasing stock for deserving employes, not known as "junior partners." Some of this stock was afterward withdrawn by several of the stockholders through a disagreement, but the endowment still remained sufficiently large to insure large annual incomes. This is the first distribution since this fund was set aside and establishes a precedent which will no doubt be followed hereafter despite the formation of the United States Steel Corporation. Andrew Carnegie last year gave $4,000,000 in 5 per cent bonds of the United States Steel Corporation, the interest to be given to disabled and deserving employes as a pension. The first distribution from this sum will be made about the first of the year. Some of the beneficiaries received their securities outright, while others received only half outright, the remainder to be purchased within ten years.

Those employed at the Edgar Thomson plant who received bonds or stock outright are as follows, with their term of service: Thomas James, master mechanic and formerly foreman of the "floating gang" of machinists, at the steel works 27 years; Thomas Addenbrook, superintendent of construction and foreman of masons and bricklayers, 27 years; David L. Miller, superintendent of the rail and bloom mills, 26 years; Andrew Jackson Boyle, night superintendent of the entire steel plant proper, 25 years; Thomas Cosgrove, now superintendent of labor and transportation, and previously foreman of laborers at the Edgar Thomson steel works and blast furnaces, 27 years; Consor McClure, master of the roll turning shops, 20 years; Harry W. Benn, superintendent of the converting department and formerly assistant superintendent, 18 years; Edward B. White, chief inspector at steel mills and furnaces, 23 years; Richard Stevens, for 22 years master mechanic at the blast furnaces, and now steam and machinery expert of the furnace department, 24 years; George Nimon, foreman of the pattern shops at the steel works, 25 years; John Noey, superintendent of boilers at the steel works and blast furnaces, 25 years, and Hezekiah Scritchfield, boss heater in the rail and bloom mills, 25 years.

Those who received only one-half of their allotted amounts at this plant follow: George Brassett, present superintendent of the nine blast furnaces, and previously assistant superintendent, five years, having come to Braddock from Germany; John F. Lewis, now master mechanic at the blast furnaces and formerly a machinist, starting at the plant as a messenger boy, 25 years; Michael Killeen, assistant superintendent of the blast furnaces the past 15 years, and formerly at the Lucy furnaces; Charles E. Dinkey, assistant general manager of steel works and furnaces the past year, formerly superintendent of the foundries, a brother of Mrs. Schwab, wife of Charles M. Schwab, president of the United States Steel Corporation, with the Edgar Thomson plant 12 years; Andrew McWilliams, master carpenter at the steel mills, 22 years; Frank Gray, chief clerk at the Edgar Thomson works for 14 years, and at the Duquesne Steel Works, a total of 20 years; David Melville, assistant chief clerk, 22 years; Edward R. Oskin, chief paymaster at the Edgar Thomson works for four years, and formerly a clerk, 12 years; George Harris, superintendent of the finishing mills, 12 years; Charles B. Murray, chief chemist of the steel mills and furnaces, eight years, and Edward E. Slick, chief engineer of the entire plant for four years, and formerly a draughtsman, 15 years.

The Homestead employes who shared in the distribution are as follows: William Williams, superintendent of the plate mills; George Glunt, superintendent of the 119 and 32-inch mills; Charles Orchard, chief shipper; Morgan Harris, superintendent of the forging department; E. H. Wood, assistant superintendent; John Unger, superintendent of the armor plate department; Harry Davis, master mechanic; John

Shaddock, superintendent of the 48, 30 and 24-inch mills; Julian Whigom, superintendent of the Howard axle works; George Hemfeldt, superintendent of the Carrie furnaces; George Forrest, superintendent of open-hearth furnace No. 3; Reese James, superintendent of open-hearth furnaces Nos. 1 and 2; David Kennedy, superintendent of the 42-inch mill; Thomas Jamison, superintendent of the converting mill; W. H. Dickson, superintendent of construction; George Gross, superintendent of beam mills; R. L. Irwin, chief clerk; William Corbett, paymaster; J. W. McCrady, chief inspector; John Hartman, chief timekeeper.

Among the employes who received large gifts at the Duquesne plant, the following are prominent: Edward Hamilton, assistant to the general superintendent; A. M. Diehl, superintendent of furnaces; J. R. Davis, superintendent of the bar mill; H. K. Williams, superintendent of the merchant mill, and W. F. Milligan, chief timekeeper.

It is understood that the entire amount represented in the distribution is $3,000,000.

Personal.

Charles M. Schwab, president of the United States Steel Corporation, while in Washington last week was a guest of President Roosevelt at luncheon.

Andrew Carnegie arrived in Pittsburg last Friday and remained several days discussing matters pertaining to the new Carnegie Technical School. While in Pittsburg he was the guest of Mr. George Lauder.

George E. Klingelhofer has resigned as manager of the Pittsburg Valve, Foundry & Construction Co., Pittsburg, Pa.

R. S. McDonald, formerly connected with the Pittsburg Coal Co., has been appointed manager of the bureau of mining, established at Pittsburg by the United States Steel Corporation. Offices have been opened in the Empire Building. This new bureau will have charge of the survey and purchase of desirable coal lands and coking properties. Elmer Hough of Homestead, Pa., has been appointed assistant to Mr. McDonald.

William E. Manning, for several years at the head of the order department of the Republic Iron & Steel Co., with offices at Youngstown, O., has tendered his resignation and has accepted a position with the Youngstown Iron, Sheet & Tube Co.

The plant of the St. Louis Iron & Steel Foundry, St. Louis, Mo., was damaged to the extent of $10,000 by fire last week.

The 13-inch merchant mill of the Duquesne plant of the Carnegie Steel Co., Duquesne, Pa., will be placed in operation within a week. The cooling beds have about been completed. The foundations for the 14-inch billet mill are already in place and the machinery will soon be set. By the first of the year the entire mill will be in complete operation.

The United States Drawn Steel Co. of McKeesport, Pa., is negotiating with the real estate exchange of that place with reference to securing a large manufacturing site.

Provided a bonus can be secured Philadelphia, Pa., promoters intend to erect a pipe foundry at Lansdale, Pa. The foundry is to be 70x150 feet and the machine shop 30x70 feet.

McClave & Brooks, iron founders, will erect a new plant at Pine Brook, near Scranton, Pa. The output of the foundry will be limited to grey iron castings.

The 10-inch mill of the American Steel Hoop Co. at Mingo Junction, O., made 5,228 gross tons of steel during the month of October, breaking the former record of 5,060 tons, made by the mill last May. The sizes rolled varied from 7-16 to 1¼-in. rods and squares.

Robert Field, sales agent, has removed his office from Columbus to Cincinnati, and is now located in the Mitchell building. He will continue to act as direct sales representative of the Sloss-Sheffield Steel & Iron Co. of Alabama and in addition to their product of foundry and forge pig iron will have a line of northern foundry and malleable iron and foundry coke.

NATIONAL FOUNDERS' ASSOCIATION.

(Special Telegram.)

NEW YORK, Nov. 13.—The fifth convention of the National Founders' Association opened at the Gilsey House at 11 o'clock this morning. In point of numbers it will be the most successful convention the association has had to date and a great deal of enthusiasm is evident.

The meeting opened with the reading of the annual report of the president, H. W. Hoyt, of Chicago. He reviewed the history of the association for the past year and spoke of the Cleveland conference of last spring, which resulted in a disagreement between the Iron Molders' Union and the National Founders' Association officers on the advance in wages asked for by Cleveland molders. He congratulated the Cleveland foundrymen on the year of perfect quietude, so far as strikes were concerned, since the struggle of 1900-1901 and also upon the amount of business and the general prosperity they have enjoyed. He went carefully over the history of the Chicago strike and reviewed the many conferences and the final results therefrom. He stated that with but very few exceptions the entire Chicago membership stood firmly together, brought fully a dozen non-members into line, and the result had been an unqualified victory for the foundrymen of that city.

Mr. Hoyt summed the Chicago matter up by saying that if the National Founders' Association had expended in Chicago on this strike alone all the money which it has expended in strikes all over the country, a better result would be impossible, and it could not have terminated in more far-reaching benefits. Mr. Hoyt spoke of the discussion which had been going on with reference to the abolishment of the differential in wages between floor and bench molders and criticised the position taken by the molders with reference thereto. He spoke of the splendid work of capable foremen and said that such men were equal to the task of pulling a firm through almost any emergency with a union. Referring to the New York agreement he said that while the time would surely arrive when the N. F. A. would not advocate the making of an agreement with an irresponsible party, yet he would advocate the retention of the New York agreement until a better one presented itself. He said that while results show that the strikes which have been visited on the N. F. A. have really accomplished many desirable results, yet the greatest gains which the association has made have been derived from the many conferences and agreements and the beneficial effects of a better acquaintance of the officers on both sides.

A great deal of credit was given to the officers of the Iron Molders' Union by Mr. Hoyt for their sincere efforts to bring about a better understanding with the men and the carrying out in full of the agreements made for them. Mr. Hoyt also laid stress upon the fact that the N. F. A. is prepared to take a firm stand upon the subject of molding machines and protect its members in the full benefit obtained from the introduction at great expense of improved appliances.

Mr. Hoyt strongly recommended the appointment of a commissioner to whom all correspondence and business affairs in connection with the settlement of labor troubles should be referred. A large percentage of the work which has hitherto fallen to the president, members of the administrative council and the committees will now go direct to the secretary's office.

The report of Secretary Penton reviewed at length the situation in all parts of the country, gave particulars of all the difficulties that have arisen from year to year and character of settlement.

The treasurer, John R. Russel, of Detroit, read his report, which showed a very satisfactory balance on hand in the treasury.

About 200 members are present, among them ex-Gov. A. S. Bushnell of Ohio and many other prominent business men.

The Vulcan Iron Works of Toledo, O., has just completed the shipment of two large shovels to Nova Scotia. The one shovel weighs 78 tons and has a guaranteed capacity of 2,500 cubic yards per day, while the other weighs 55 tons and has a guaranteed capacity to handle 1,800 cubic yards per day.

Landmarks in the Rolling Mill History of the United States.

By WM. GARRETT.

That Cort was the first man to roll iron in grooved rolls is beyond dispute. The value of this invention to the world is incalculable, and what would have been the state of civilization had this process of reducing iron never been adopted is beyond conjecture. All the rails on our railroads, plates for steam boilers, plates for our vessels, and rivets and bolts for the same, our bridges, our telegraph and telephone systems would have been an impossibility without the rolling mill process. Take away all the benefits derived from Cort's invention and we would be back once more in the state of civilization prior to 1783. Cort's discovery is the corner-stone of the rolling mill industry. But many improvements have been made since that time in the rolling of iron and steel. Indeed, the introduction of Bessemer steel made it possible to adopt many methods that tended greatly to cheapen the process of rolling material; and some rolling mills that are considered among the best we have today would be almost entirely useless in the rolling of iron. The Bessemer and open-hearth processes for steel-making might be considered the main link perfecting the chain of events in rolling mill development up to the present time.

Wm. Garrett.

In this paper I will only deal in a general way with some of the striking landmarks in the history of the rolling mill, based on the personal experience and observation of more than 40 years, and will refer only to some of the most striking phases.

The mill that Cort first used to roll iron must have been of a crude nature, for as the writer looks back 40 years he recalls the rude housings and rolls used at that time on what were called up-to-date mills. At that time a Cort iron bed plate was in many districts unknown. The housings were placed direct on timber. In many places keys took the place of the top screws; wedges were used for the side screws. In fact, I saw a mill of this type in operation in South Wales in May, 1901, which shows conclusively that progress in rolling mills has not been universal.

Among the first improvements on the original Cort mill was that of using three high rolls for rolling small sizes. Who was first to take this bold step is unknown to the writer. Next came the rolling of small round bars by guide, as it is commonly called, and the term is well known by all rolling mill men. These two events made it possible to roll wire rods. Certainly they mark important epochs in the history of rolling mills, but to whom the honor belongs is unknown to the writer.

Next came the reversing mills, not by the use of reversing engines, but reversing by the use of a clutch. This led to our present reversing engines and mills. Then, turning once more in the direction of 3-high mills—this time used for the rolling of iron rails—John Fritz stands out as a landmark in the history of rolling mills. But this is not the only mark he has made; for no two men have done more than the Fritz brothers, John and George, in improving the rolling mill practice of this country. The lifting tables, now so commonly used, originated with George Fritz.

About this time the continuous mills began to crop out, and as long as iron and steel wire is used the name of George Bedson will stand out prominent in connection with the manufacture of wire rods.

I am led to believe that Lewis Richards in Dowlais was the first to use an independent engine to drive a line of feed rolls for rolling mill purposes, and Windsor Richards about 40 years ago introduced the reversing mill system of using reversing engines. It might be of interest to some to know that this mill is still in operation at the Ebbw Vale works, South Wales, and the engines are of the vertical type. Here we may add that E. Windsor Richards had great faith in this system of rolling, for he followed the matter up until he put up a reversing rail mill at Bolckow-Vaughn works in Middlesbrough early in 1880, which in 1883 produced more rails than any mill in the world up to that time. And the same mill is in successful operation today rolling rails which are produced at a cost with which even the best American mills cannot cut much figure in competition.

One of the most conspicuous epochs in rolling mill history was marked by the advent of the Bessemer process. This was so signal a departure and so universally acknowledged that comment here is unnecessary, further than to state that the successful manufacture of low carbon steel added new laurels to former achievements and benefited the world to an immeasurable extent. This was accomplished about the same time by the Bethlehem Iron Co. and the Troy Steel Co., and Messrs. Hunt, Fritz and Leiberts were the prime movers in this development. From this came the successful rolling of rods on a continuous mill. The attempt had been almost given up through the failure of rolling iron wire rods; but with Bessemer steel it also became practical to roll No. 5 rods from a steel billet 4 inches square, and to produce the large tonnage now made on what is termed a "Garrett" rod mill.

While C. H. Morgan was not the inventor of the continuous rolling mill, few, if any, have done more to perfect the

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IN THE Garrett rod mill, with which his name is inseparably connected, Wm. Garrett, the well known rolling mill engineer, of Cleveland, has an enduring monument. His invention was a decided revolution in prevailing methods, bringing nearly 100 per cent increase in output with a marked decrease in labor. Mr. Garrett was born in England. His rolling mill career began in the works of Scotland. He started in the mill at 11 years of age and at 16 was operating a guide mill. What the ordinary boy gained at school in daylight hours, Mr. Garrett acquired by the hardest effort after his day's work was done. Coming to the United States in 1878, he found work with the Cleveland Rolling Mill Co. and was connected with its mills for the following five years. It was in 1882 that he brought out the first type of the Garrett mill. It was the first rod mill in which a 4-inch billet was rolled into a No. 5 rod without reheating. Previous to this time it was the practice to use a 1⅝-inch or 2-inch billet. Mr. Garrett's process also involved the rolling of an ingot to a 4-inch billet without reheating, replacing the practice of reducing the ingot to a bloom, which was reheated before conversion into billets. The saving involved in these improvements was at that time about $7 a ton. As indicating the vitality of this invention, it is stated that substantially 80 per cent of the rods in the United States today are the product of Garrett mills.

Mr. Garrett went to Pittsburg in 1883 and in that year built the rod mill in the Oliver Wire Co.'s South Side plant. Returning to Cleveland in 1886 he built a rod mill for the American Wire Co. Later he was connected with the Joliet Steel Co. at Joliet, Ill., building there a rod mill which later became one of the Illinois Steel Co. properties and is now operated by the American Steel & Wire Co. It is a mill noted for record-making. The two finishing mills recently produced 877 tons of No. 5 rods in 24 hours, and they have made 10,000 tons each in a given month. In the near future this latter is expected to be a regular record. Mr. Garrett removed to Cleveland in 1897 and established the Garrett-Cromwell Engineering Co. His partners in this enterprise are H. W. Lash and John C. Cromwell. The firm has grown rapidly and has now on its books a number of important contracts in connection with the extension of large iron and steel works and the building of new ones.

process. His efforts and the results obtained make him a conspicuous landmark. While there are other bright and shining marks, special prominence will always be given his name. Another notable landmark in this connection is F. H. Daniels. Partly in connection with C. H. Morgan and later alone he has brought out many marked improvements that entitle him to a prominent place in the history of rolling mills. The continuous rod mill at Waukegan (the only continuous mill to this date that can roll a multiplicity of rods at the same time) alone entitles him to special mention. And no one has done more than he to perfect wire drawing in all its phases. Today he is chief engineer of one of the largest steel corporations in the world, and is still making history.

The treatment of this subject so far as wire rods are concerned would be incomplete without mention of another landmark, one that revolutionized the rolling of wire rods and created a new article of commerce, viz., the 4-inch steel billet —a mill in which nearly 90% of the rods used in this country are produced at the present time. By some it is called the "Garrett" mill, by others the "Belgian" mill. But no matter about that, for no doubt the mill as it is would produce as many rods were it called by any other name. This mill is so familiar that no explanation is necessary. It has made, and is still making, history. So the mill, at least, call it what you will, took its place in 1883 as a landmark in rolling mill history. And at this time, 1901, there are six of these mills in course of construction.

Before touching upon what has been accomplished in steel rail rolling, it is but fair to pay a passing tribute to those who were most successful in making iron rails. As already mentioned John Fritz's introduction of the 3-high system was a marked improvement, and made possible the production of not only a better iron rail, but also of a larger quantity. From what I can gather the Cambria Iron Co. at one time produced not only the largest quantity, but also iron rails of a superior quality. Still there were others who produced iron rails, chiefly the Superior Iron Co., at Woods Run, Pittsburg, managed by David Mathias. At this mill were produced iron rails of such a quality as to make questionable at that time the superiority of a Bessemer steel rail. If I am not wrongly informed, the rail mill referred to produced the largest out-

The Late Capt. Wm. R. Jones.

The Late Alexander L. Holley.

THE LATE CAPT. WILLIAM RICHARD JONES.—The Jones metal mixer, considered by steel experts the most important invention in the development of the Bessemer process in the past quarter of a century was one of the many devices patented by Capt. William R. Jones, whose tragic death occurred on September 28, 1889. The inventor did not live to see his patent issued, but shortly before his death he was notified that the patent was allowed. (Some time ago suit was commenced by the Carnegie Steel Co. against the Cambria Steel Co. in which the validity of this patent is called into controversy.) Next to his prominence as an engineer, Capt. Jones was noted for his geniality, frankness, humor, courage and energy. As a manager of men he combined justice and sympathy with uncompromising authority.

He was born in Luzerne county, Pa., Feb. 23, 1839. His father was Rev. John G. Jones, a Welsh minister who had emigrated to the United States in 1832. Owing to the early death of his father, and being the eldest son, he was self-supporting at an early age. At ten he was apprenticed to the Crane Iron Co. of Catasauqua, Pa., and in this humble way entered upon a profession in which he became famous. At 20 he entered the employ of the Cambria Iron Co. as a machinist, and continued in that capacity until July, 1862, when he enlisted as a private in the 133d Regiment of Pennsylvania Volunteers. Owing to his bravery he soon commanded a company. The regiment was mustered out of service in 1863, and Capt. Jones re-enlisted in the 194th Pennsylvania. After his final discharge he resumed his connection with the Cambria Iron Co. and became assistant to George Fritz, the brilliant mechanical engineer then in charge of the works at Johnstown, Pa. Until Mr. Fritz's death, Captain Jones was busy under his direction in designing, erecting and perfecting the great Bessemer mill and other plants of the company. This position he left to become master mechanic and later general superintendent of the Edgar Thomson Works at Braddock, Pa., now owned and controlled by the Carnegie Steel Co. It was under his direction and supervision that blast furnaces A, B, C, D, E, F and G of this plant were erected. As is well known, an explosion at one of these furnaces inflicted injuries upon Capt. Jones, of which he died after two days.

Many patents were granted Capt. Jones, the most important of which are a device for operating Bessemer ladles, improvements in hose couplings, fastenings for Bessemer converters, washers for ingot molds, hotbeds for rails, apparatus for compressing ingots, cooling roll journals and shafts, feeding appliances for rolling mills, manufacture of railroad rolls, apparatus for removing and setting rolls, housings for rolls, apparatus for removing ingots from molds, method for mixing in receiving tanks the metal from blast furnaces. Capt. Jones was an active member of the American Institute of Mining Engineers, American Society of Mechanical Engineers, Engineers' Society of Western Pennsylvania, and the Iron and Steel Institute. On Oct. 3, 1889, at a joint meeting of Carnegie Brothers & Co., Ltd., and of Carnegie, Phipps & Co., Ltd., held at Pittsburg, suitable resolutions upon the death of Capt. Jones were adopted. They express in the strongest terms the esteem in which he was held by his employers.

put in one year ever obtained, viz., over 42,000 tons. Mr. Mathias's ability in this direction, and the pace he set for others, entitle him to be recognized as another landmark in rolling mill history.

Coming to Bessemer steel and steel rails, first referring to achievements in Great Britain, we have the names of Menilaus, Richards, Martin, David Evans, Lowthian Bell, William Evans, and others who were pioneers in the development of this remarkable process for making steel. They certainly are landmarks, and some are still making history.

When we come to the remarkable achievements in this country in the making of Bessemer steel and steel rails, and when we seek to find the starting point and to discover who gave us the start, the name of Holley stands out so prominent that when it is put in the roll of epoch-makers it should be written in raised letters. The insight, skill and perseverance he showed and the wonderful results he obtained during his short career make his work something more than a landmark. Time will not permit me to go into details; the early history and the rapid strides made under his lead speak for themselves.

The history of the steel industry would be incomplete indeed without the mention of Capt. William R. Jones, and what he accomplished. His remarkable success and untimely end will be remembered and commented upon by future generations. The Edgar Thomson works, just as they stand today (excepting a few additions), designed and erected and brought to successful operation by him, are alone a monument to his fame, outlasting bronze or marble. Quick to think, then prompt to execute, with judgment of the best, he for years led all competition. And it was not until the appearance of Robert Forsyth, who designed and erected the steel works and rail mill at South Chicago, which today in general lay-out is exactly as he first designed it, that any one approached the master manager at Edgar Thomson. Today it is almost neck and neck between the two mills for the greatest output. There is no question that these two plants are the largest producing rail mills in the world. So no one will question that Capt. Jones and Robert Forsyth are prominent landmarks in the history of rolling mills.

No country in the world avails itself of the use of automatic machinery to save labor as does the United States; and this is applied in some places where its use was at one time thought impossible. While automatic machinery is quite common today, at one time rolling mills were operated by manual labor. The men who brought about the results we see in this line are certainly entitled to places in the Temple of Fame. Notable among this class are Capt. R. W. Hunt, Messrs. F. H. Treat, Charles Pettigrew and H. S. Smith. The former, while at the Troy Steel Co.'s works, and the three latter, while at the Joliet Steel works, introduced movable tables, troughs, etc., whereby for the first time in history a Bessemer steel ingot could be bloomed, cut in two or more parts, then rolled into a finished rail without the aid of a single tongsman, and output obtained that would have been impossible under the old method; this being so surely they are entitled to important places among rolling mill landmarks.

Thirty years ago few steel plates were made in this country. In my mind two men stand out very prominent in connection with the rolling of plates. First, Bernard Lauth, who invented the 3-high plate mill with small roll in the middle, and S. T. Wellman, who was the first to put it to practical use in this country. At one time the only mill of any note in the country for rolling steel plates was that of the Otis Steel Co.

Robert W. Hunt.

Robert Forsyth.

John Stevenson, Jr.

ROBERT WOOLSTON HUNT was born in Fallsington, Bucks County, Pa. His first experience in iron and steel manufacture was obtained in the rolling mills of John Burnish & Co., Pottsville, Pa. Later he studied analytical chemistry in the laboratory of Booth, Garrett & Reese, Philadelphia; and then entered the employ of the Cambria Iron Co. at Johnstown, Pa.; established there as part of an iron making plant the first chemical laboratory in American. Later he was given charge of the steel department of the company's works and by them sent to the experimental Bessemer, or as it was then called "Kelly Process" plant, at Wyandotte, Mich. The first Bessemer steel produced in this country was made in this plant about six months before Mr. Hunt assumed its management. After a year he returned to Johnstown, and assisted George Fritz, chief engineer of the Cambria Iron Co., in designing and erecting a Bessemer steel plant, and upon its completion assumed its management. In 1873 he accepted a similar position with the firm of John A. Griswold of Troy, N. Y. That firm consolidated with others resulting in the formation of the Rensselaer Steel & Iron Co., and later the Troy Steel & Iron Co., of both of whoch he was the general superintendent. During this time he rebuilt the Bessemer works and the various merchant mills of the company and introduced in the rail mill the first automatic tables in connection with the rolls, saving the labor of some 12 men. These tables were protected by U. S. patents issued in the names of Mr. Hunt, Max M. Suppes and Wm. R. Jones. Practically in every rail mill in the country tables were introduced under licenses from the patentees. Mr. Hunt also secured several patents relating to the manufacture of Bessemer steel, both individually and in connection with Dr. August Wendel, the chemist of the Troy company.

Under Mr. Hunt's direction three blast furnaces were built on an island in the Hudson River, opposite the Bessemer steel works, and it was arranged for direct metal to be taken from them across the river on a ferry boat to the converters of the steel plant. This was successfully accomplished. In 1888 M. Hunt resigned his position in Troy and established the firm of Robert W. Hunt & Co., with headquarters in Chicago, and other offices in New York and Pittsburg. Their bureau of inspection, tests and consultation has earned a world-wide fame and clientage.

During the Rebellion Mr. Hunt served in the Army of the Potomac as a sergeant of cavalry and as mustering officer of Pennsylvania with the rank of captain. He was also in command of Camp Curtin, a camp of rendezvous at Harrisburg, Pt. He is a member and past president of the American Institute of Mining Engineers, American Society of Mechanical Engineers, and Western Society of Engineers, and is a member of the American Society of Civil Engineers, the Engineering and Maintenance of Way Association, the Institution of Civil Engineers, Institution of Mechanical Engineers, and Iron and Steel Institute. He has contributed frequently to the proceedings of the several societies, and also to the technical press. Capt. Hunt is also a trustee of the Rensselaer Polytechnic Institute, Troy, N. Y., and was for three terms commander of Post Griswold, G. A. R., of Troy.

ROBERT FORSYTH was born in Troy, N. Y., and graduated in the class of '69 at the Rensselaer Polytechnic Institute, taking the degree of civil engineer. In January, 1870, he entered the Bessemer Steel Works at Troy under Alexander L. Holley, and remained there for two years as student and draftsman.

The success of this mill was such as to quantity and quality that the attention of the whole country was attracted, and S. T. Wellman was the first man to make the open-hearth steel process a perfect success in the United States. At the Otis Steel Works they established a standard as to quality for fire box and boiler plate that has never been excelled, and a specification of quality "as good as Otis steel" is preferred to that of Lloyd's or any other standard specification. Mr. Wellman's ability to produce high carbon steel by the open-hearth compelled nearly all crucible steel makers to adopt this process to supersede steel made by the crucible process for bar and buggy springs. Not to speak of his other improvements, the Wellman charging machine, now universally used, is enough to place its designer in the front rank among those who have made modern steel works practice what it is. It is not in the least out of place to say that what Holley was to the Bessemer process Wellman is to the open-hearth steel industry in this country.

As Paul sat and was taught at the feet of Gamaliel, so H. W. Lash was taught the open-hearth process by S. T. Wellman, but at an early date he cut loose and struck out for himself. He was among the first, if not the first, to make basic open-hearth steel successfully—this under the supervision of Sidney G. Thomas (1878); the first to put the entire charge of cold metal at one time into an open-hearth furnace (thereby increasing the output); among the first to retain the carbon in the bath for high carbon steels. He struck out from the old groove as to style of melting furnace, and today the melting furnaces of the Carnegie Steel Co., who are the most successful makers of open-hearth steel, embody many of the improvements suggested and adopted by H. W. Lash He was also among the first to adopt the pig and ore process.

Prior to 1892 this country produced little if any tin plate. Today the tin plate mills in operation, in the course of construction, and in contemplation will give a greater capacity than the requirements of the United States, namely, over 400,000 tons per annum. In line with our search for landmarks in the history of rolling mills (having the manufacture of tin plate in view) two men stand out most prominent; first, our late and lamented president, William McKinley, the father of a protective tariff bill that made it possible for the American capitalist to embark in the tin plate trade; second, John Stevenson, Jr., now of the Sharon Steel Co., who has done more to perfect and improve the method of rolling black plate and reducing its cost than any other man in this or any other country. He took a bold departure in one respect that stands conspicuous—the driving of hot mills by ropes instead of by a gear. His plans and designs have become the standard, and the first-class black plate mills now in construction are following, and those in contemplation must needs follow, strictly the lines laid out by Mr. Stevenson. Here we can safely say that what Holley was to the Bessemer process, Wellman to the open-hearth process, Capt. Jones and Robt. Forsyth to the rolling of steel rails, Morgan and Daniels to the wire and wire rod industries of this country, that John Stevenson is to the manufacture of tin plate.

One of the most striking characters connected with the manufacture of iron and steel in this country is Henry Wehrum, who, in spite of the fact that our leading engineers clung to the 3-high system of rolling iron and steel, struck out boldly and adopted the reversing system, and is today the leading exponent of that type of rolling in this country. The company with which he has so long been identified has always been in a prosperous condition, and has passed through many seasons of depression which have swamped or shipwrecked. The iron and steel trade is indebted for many improvements

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Late in 1871 he went to Chicago as assistant superintendent of the Bessemer plant of the North Chicago Rolling Mill Co., then under construction. This plant was started in 1872, and for many years (under Mr. Forsyth's management after 1873) held a position, for quantity and quality of product, at the head of the Bessemer Works of the country. It was probably the best of the small plants (5 to 6 tons) designed by Mr. Holley. When the North Chicago Rolling Mill Co. decided to build at South Chicago a plant consisting of four furnaces, a Bessemer works and a rail mill (the nucleus of the present immense plant of the Illinois Steel Co.), Mr. Forsyth was sent to Europe to investigate European practice and on his return designed and built the Bessemer department of the works. This plant was notable at the time (1882) for having three vessels, with removable shells on Holley's plan to facilitate anticipated basic work, and as being the first plant in the country designed to work metal direct from the blast furnace. No cupolas were installed until three or four years later, when one was put up for melting scrap, and the plant continued to work direct metal until 1892 when Mr. Forsyth put in a pair of mixers. Leaving the service of the North Chicago Rolling Mill Co. in 1894 Mr. Forsyth went to Pittsburg in 1884 as superintendent of the Spang Steel & Iron Co., but returned to Chicago in 1885 to become manager of the Union Steel Co. and to rebuild for that company the works of the old Union Iron & Steel Co. This involved the construction of a new Bessemer Works and rail mill, in both of which some novel features were developed. When in 1889 the works in and about Chicago were consolidated to form the Illinois Steel Co., Mr. Forsyth became chief engineer of that company, and in that capacity reconstructed the rail mill at South Chicago, originally a 2-high reversing mill, putting in the present 3-high train which has made such remarkable rec ords in rail rolling. In conjunction with S. T. Wellman as consulting engineer, he built the open-hearth plant and plate mill at the same works. Mr. Forsyth became second vice-president of the Illinois Steel Co. in 1894 and in 1896 he retired from the service of the company and is now practicing as a consulting engineer in Chicago.

JOHN STEVENSON, JR., the leading figure in the most important competitive steel company that has built works since the consolidations were formed, is a native of Glasgow, Scotland, and is 53 years old.His father was a mechanical engineer. The son left school at 13 and entered on a seven years' apprenticeship in the machine shop, pattern shop and drafting room. At the same time he attended night school, taking one of the Queen's prizes and several scholarships in competition with older pupils. At 22 he came to the United States with the thought of making a fortune and returning to Scotland. He was first employed at Mackintosh, Hemphill & Co.'s Pittsburg, as draftsman, and later went to Edgar Thomson Steel Works, being associated with Capt. Jones in 1876. Again he became connected with Mackintosh, Hemphill & Co., this time as a partner. In 1883 he removed to New Castle and for two years was identified with J. P. Witherow & Co., leaving this position to build the New Castle Nail Works. In turn came a wire mill, rod mill, steel plant, tube mill, tin plate plant and blast furnaces. Mr. Stevenson's interests in all these was disposed of to various consolidations, and soon after the organization of the Sharon Steel Co. by F. H. Buhl and others Mr. Stevenson acquired a large holding and is general manager of the company. He is president of the Sharon Tin Plate Co., an identified concern.

EXTENDED REVIEW of the career of S. T. Wellman appeared in *The Iron Trade Review* of Dec. 13, 1900, at the time of his election to the presidency of the American Society of Mechanical Engineers. In the present issue the article of Mr. Monell on our open-hearth progress indicates how prominent a place Mr. Wellman has had in the development of that industry. We need therefore to refer here only briefly to the important service he has rendered the iron industry. Born at Wareham, Mass., in 1847, he inherited an aptitude for the work he has followed, his father being superintendent of the Nashua Iron Co. S. T. Wellman worked in the machine shop and later in the works of the Nashua Iron Co. When the first Siemens gas regenerative furnaces were being built in the United States Mr. Wellman was engaged in erecting them. After some years at Pittsburg Steel Works, Mr. Wellman built for the Bay State Iron Co., Boston, the first open-hearth furnace in the United States to make steel on a commercial scale. Later he was connected in turn with the Nashua Steel Co., the Otis Steel Co., the Illinois Steel Co., and the Chester Rolling Mill Co. At the Otis works he manufactured the first basic open-hearth steel turned out in this country. The organization of the Wellman-Seaver Engineering Co., of Cleveland, of which Mr. Wellman is president, dates back only six years, in which time the company has come to occupy a large place in steel works engineering. Mr. Wellman is a member of the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining Engineers, the Iron and Steel Institute, the British Institution of Mechanical Engineers and the Verein Deutscher Eisenhuttenleute.

CHARLES HILL MORGAN was born at Rochester, N. Y., in 1831, of New England parentage. He was obliged to work in a factory at 12 and at 15 he entered the machine shop of his uncle, J. B. Parker, of Clinton, Mass., as an apprentice. At 17 he studied mechanical drawing in a night class taught by the late John C. Hoadley. In 1852, when only 21 years old, Mr. Morgan was put in charge of the Clinton mills dye house; at this time he devoted himself closely to the study of chemistry. For some time Mr. Morgan was draftsman for the Lawrence Machine Co.; later, from 1855 to 1860, he was mechanical draftsman for the distinguished inventor and manufacturer, Erastus B. Bigelow. About this time Mr. Morgan introduced a system of designing and constructing cam curves for looms,

developed under the supervision of Mr. Wehrum, and he certainly stands out prominently as a landmark in the history of rolling mills.

Among the most prominent in developing and improving the puddling process in this country was John I. Williams. Early in the seventies he was producing puddle iron made by Danks' process so successfully as to make many hesitate in their belief that Bessemer steel would supersede puddled iron. Had we the same knowledge then that we have at the present time in hydraulics his success would have been still more marked, and puddle balls weighing nearly one ton would have been successfully handled. He, beyond a doubt, brought the Danks furnace nearer a state of perfection than any other man, and I firmly believe had it not been for the advent of the Bessemer process, that developments and improvements would have been made with the Danks puddling furnaces that would have brought them into universal use. This and his remarkable success in producing iron bars and plates of such a quantity in a given time, and of such quality at one time, and setting a pace for all others, surely entitle John I. Williams to stand among the landmarks in rolling mill history.

Time and space will not permit us to follow this subject in detail further, and I hope the many landmarks that I no doubt have missed will please attribute this, first, to the lack of space, and next to the lack of direct knowledge by the writer. Let me conclude this somewhat rambling sketch by referring to three corporations that are most striking landmarks in rolling mill history: 1, what was known as the Washburn & Moen Wire Co.; 2, the Cleveland Rolling Mill Co.; 3, the Carnegie Steel Co.

F. H. Daniels, in his able paper read before the Mechanical Engineers in 1893 (World's Fair) stated that I. Washburn was one of the prime movers in the early history of that company. No doubt he had the power to reject or adopt any scheme presented by the management. He allowed the adoption of the Bedson continuous rod mill, and for several years after its completion it was anything but a success; but all this time he allowed the money of the company to be expended, believing in its ultimate success. Then their success in the wire drawing industry was such that in a short time they became not only the most successful wire manufacturers in this country, but in the world. In fact, there is not a wire mill in this country today, almost without exception, but has been indebted to the Washburn & Moen Wire Co. for the

S. T. Wellman.

C. H. Morgan.

F. H. Daniels.

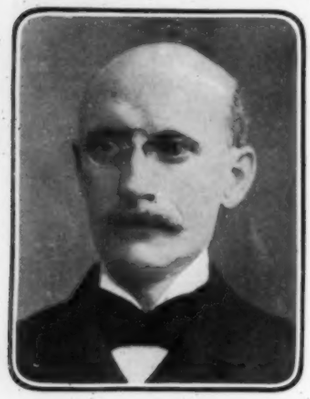
which proved very successful. In 1860 Mr. Morgan formed a partnership with his brother for the manufacture of paper bags in Philadelphia, making improvements in machinery that put this industry on a commercial footing. In 1864 Hon. Ichabod Washburn engaged Mr. Morgan as superintendent of manufacturing for Washburn & Moen at Worcester. Four years later the Washburn & Moen Mfg. Co. was organized and Mr. Morgan was made general superintendent. He made seven trips to Europe for the company, visiting mills in England, Belgium, France, Germany and Sweden. From these trips and from a study of patents and the literature of wire manufacturing, he introduced improvements which added to the quality, variety and excellence of the company's product. For 11 years he was a director of the company. From 600 men employed the number increased to 4,000 when Mr. Morgan took up other lines of work.

An advanced step was the development by Mr. Morgan of the continuous rod rolling mill, originally built by George Bedson in Manchester, Eng. Mr. Morgan's first important improvement was a power reel; his second was the practical development of a continuous train of rolls, having horizontal rolls only, in place of the alternate horizontal and vertical axes. In Mr. Morgan's mill the intermediate twist guides between the rolls give the metal one-quarter of a turn in passing from one pair of rolls to the next. Nine years after the construction of the Bedson mill, a third mill, from new designs furnished by Mr. Morgan, was built on the Belgian and continuous plans. It was known as the combination mill. The third improvement was the invention by Mr. Morgan of an automatic rod reel of the pouring type. This was completed and a successful test made in March, 1886. The automatic pouring reel now in use in nearly every rod mill in the country was the joint invention of Messrs. Morgan and Daniels. In 1887 Mr. Morgan resigned his position as general superintendent of Washburn & Moen Mfg. Co., after 23 years of service. He had founded, in 1881, the Morgan Spring Co., manufacturers of steel springs, and now devoted his attention to the development of this business, the scope of which was enlarged to cover steel wire of every variety as well as springs. Four years later, in 1891, the Morgan Construction Co. was incorporated to manufacture rolling mill and wire drawing machinery. The work of Mr. Morgan and his associates in the last named company has been most successful The continuous rolling of such material as billets, merchant bar, rods and hoops, together with the disposition of the product after it has been rolled, has been given special attention and a large number of important installations made. The continuous method of heating billets, while not strictly new, has been developed and introduced, culminating with the continuous gravity discharge furnace and the suspended arch furnace, both invented by Mr. Morgan. Mr. Morgan has made his home in Worcester, Mass., for 36 years. He has always been interested in educational matters, and has been most closely identified with the growth of the Worcester Polytechnic Institute, having been a member of its board of trustees since the institution was founded, nearly 35 years ago. Mr. Morgan became a member of the American Society of Mechanical Engineers in 1881, the year following its establishment, was a manager from 1884 to 1887 and president in 1900. He is also a member of the American Institute of Mining Engineers, the Iron and Steel Institute, and an honorary member of the Society of Civil Engineers of France.

Fred Harris Daniels was born in Hanover, New Hampshire, June 16, 1853. His parents, who were descendants from early settlers of New England, moved in 1854 to Worcester, Mass., where Mr. Daniels has resided until the present time. Graduating from the public schools of Worcester, he entered the Worcester Polytechnic Institute in 1870, and graduated in 1873, as a mechanical engineer. Immediately he entered the employ of the Washburn & Moen Mfg. Co., who were pioneers in the manufacture of wire rods and wire, becoming head draughtsman. In 1875 and 1876 he acted as assistant in chemistry to Dr. Thomas M. Drown at Lafayette College. Returning to Worcester he served the Washburn & Moen Co. as chemist and mechanical engineer. In 1877, in the interest of the company, he made a tour, studying the Swedish methods of producing choice qualities of iron and steel, and thoroughly investigating the French, German and English methods of rolling wire rods and producing wire. This occupied about one year. About this time Mr. Daniels made numerous inventions relating to the rolling of rods and reeling them continuously and automatically. These are now in successful operation in this country and in Europe. After serving the Washburn & Moen Co. as assistant superintendent, general superintendent and chief engineer, the Worcester plant being more than doubled and new plants added at Waukegan, Ill., and San Francisco, Mr. Daniels became associated three years ago with the American Steel & Wire Co. as chief engineer, on the sale to the latter of the Washburn & Moen Co.'s interests. Mr. Daniels has made many inventions which have proved of great value to the companies with which he has been associated and his name is inseparably connected with the development of the wire industry in the United States.

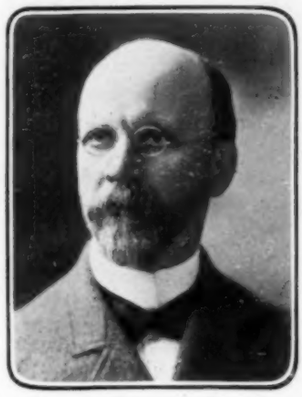
skilled men to start and put it in operation. They are without doubt the parent company of our wire industry. While others have followed, none have excelled them in variety and quality of production. They were first to give the farmers of not only this country, but of the world, barbed wire fence; first to give the piano makers of this country piano wire; and today they make wire for a greater variety of purposes than any other single wire company in the world. The leading and guiding spirit who laid the foundation of the present greatness was I. Washburn. Surely he is entitled to rank among the leading landmarks in rolling mill history.

Cleveland Rolling Mill Co. "Take care of the pence and the pounds will take care of themselves," is an old proverb, and at one time this adage could be applied with force in the Bessemer steel business. Take care of the scrap and the regular stock will take care of itself; for at one time it was a problem to know what could be done to utilize the scrap, such as crop ends of rails, etc., and monuments of this material were to be found piled up in every Bessemer steel plant. All were at a loss as to how to dispose of it. I consider that the late Henry Chisholm (at one time president of the Cleveland Rolling Mill Co.) was the first to solve this problem, and this, in spite of many failures in the various experiments made, and the adverse opinions of his practical rolling men, who claimed that his idea (which was to make a solid billet out of the crop end of a Bessemer steel flat bottom rail) was impossible. That this was accomplished is a matter of history. As a matter of fact over 18,000 tons of crop ends were rolled into billets and then finished into wire rods in one year. Not only this, but with the persistence of all strong-minded men he encouraged and even compelled his foreman to try and try again until success was the result, and steel scrap of all kinds was used up to advantage. I believe the Cleveland Rolling Mill Co. were the first to solve what was at one time a very vexing problem, viz., what to do with Bessemer steel scrap. I know of no steel company in my experience of the last thirty years that has done more than the Cleveland Rolling Mill Co. to open up the field for the general use of Bessemer steel; this, not speaking of steel rails in which even at one time they were in the front rank as producers. They were the first to roll Bessemer steel into wire rods, and this from the crop end of a steel rail. They were the first, or among the very first, that melted steel scrap in the Bessemer process; first to roll Bessemer steel in the same rolls and grooves used for rolling iron; the first to use Bessemer steel scrap in a box pile, using steel scrap exactly as



James Gayley.

Horace W. Lash.



Chas. Pettigrew.

JAMES GAYLEY, vice president of the United States Steel Corporation, in charge of ore, dock and vessel properties, was born in West Nottingham, Md., received his early education at the local Academy and after graduation entered Lafayette College, Easton, Pa. At the completion of the course in mining and metallurgy, he became chemist for the Crane Iron Co., at Catasauqua, Pa., and three years later accepted a similar position with the Missouri Furnace Co. of St. Louis, and subsequently was made superintendent of the works. When the company disposed of its leased plants, he returned to the East as furnace superintendent of the E. & G. Brooke Iron Co., at Birdsboro, Pa. In the fall of 1885 he became furnace superintendent of the Edgar Thomson plant and on the transfer of Mr. Schwab was appointed general superintendent; in 1895 entered the general office in Pittsburg and upon the retirement of Mr. Curry he succeeded to the management of the ore department, and also became a member of the board of managers of the Carnegie Steel Co. A detailed sketch of Mr. Gayley's career appeared in our issue of April 25.

HORACE W. LASH is a native of Western Pennsylvania. His experience in the manufacture of iron and steel dates back to the year 1874, at which time he started with the Otis Steel Co. at Cleveland, O. It was here under the direction of S. T. Wellman he received his early training in open-hearth steel practice. In 1876 Mr. Lash accepted a position with the Cleveland Rolling Mill Co., in charge of the open-hearth department, giving up this position in 1878 to go abroad to study the European methods of steel making. It was during this time that he met Mr. Sidney G. Thomas of London, inventor of the basic process. They soon became fast friends and spent several months together at Thy-le-Chateau, Belgium, in developing Mr. Thomas' process in the manufacture of basic open-hearth steel. In 1879 he returned home to again take charge of the open-hearth department of the Cleveland Rolling Mill Co. From here he went with Park Bros. & Co., of Pittsburg, at which place he soon built up one of the largest open-hearth steel plants in the country at that time. It was here, with the aid of natural gas, that he developed a new departure in the construction of open-hearth furnaces, a number of the features being still in use at many of the large steel plants. It was under his management that the Carbon Steel Co.'s plant was built and placed in the front rank as a producer of open-hearth steel and steel plates. Later he filled the position of president of the Minnesota Iron & Steel Co. until the sale of that company to one of the large steel consolidations. At present he is one of the partners and vice-president of the Garrett-Cromwell Engineering Co., which is one of the largest and most successful organizations in its line of operations at the present time.

CHARLES PETTIGREW was born in the village of New Lanark, Scotland, in the valley of the Clyde. Serving his apprenticeship to the machinist's trade in the Scotland Street Iron Works, Glasgow, he came to the United States in 1867 and located in Joliet, Ill., in 1870, entering the employ of the Union Iron, Coal & Transportation Co., which later became the Joliet Steel Co., which in turn was merged into the Illinois Steel Co. Mr. Pettigrew participated in the building of the plant from its beginning, taking a leading part in its development from an iron, rail and puddle mill to a foremost modern steel works. During the 26 years he was connected with the plant he advanced from the position of machinist to be manager of the entire plant, which, at the time he severed his connection with it in 1886, employed 2,300 men and consisted of three blast furnaces, a Bessemer steel plant, rail and billet mill, two rod mills, a heavy merchant mill and bolt and spike works, together with the necessary shops and foundry. Entering the steel business almost at its inception in this country he took a leading part in developing it and in bringing out those features that have made this the leading iron and steel producing country. At the Joliet plant the first blowing engine was used with the Corliss valve motion on its steam cylinders and with metal valves in its blowing cylinders. There also tubular boilers were first used in blast furnace work; and rails first rolled from the initial heat of the ingot and in double lengths. This plant was also among the first to use automatic machinery to serve a rail train and was the first to use a chain conveyor to carry scrap from a bloom shear and billets from a billet shear. Without these applications the enormous daily tonnages of the modern rail and billet mill would not be possible. Mr. Pettigrew is still actively engaged in the steel business, being at present general superintendent of the Maryland Steel Co.'s plant at Sparrow's Point, Md.

iron scrap was used; in fact, laughed at and trampled under foot all of the traditions and isms of the steel makers of the past, and at that time (1870) became pioneers in the use and method of rolling Bessemer steel. The solving of the Bessemer steel scrap problem led to the building up of the second largest wire mill in the world, that of the Cleveland Rolling Mill Co., which was the means of bringing out the idea of rolling a Bessemer ingot in one heat to a 4-inch square, and then the rolling of a 4-inch square billet without reheating into a No. 5 rod. This again made the Cleveland Rolling Mill Co. the first to roll a 4-inch billet to a No. 5 wire rod without reheating.

The value of the two latter is very hard indeed to estimate, seeing that today more 4-inch billets are made than steel rails by nearly double the quantity. And we have changed the importing of wire rods into the exporting of same, and made the use of wire so popular that over 1,000,000 tons a year is made in this country alone.

The idea of making a 4-inch billet from an ingot in one heat and a No. 5 wire rod from a 4-inch billet in one heat was conceived some four years before it was put in force, which was in 1881 and 1882. But strange as it may seem, the fact is that not before the duty on wire rods was reduced from 1.2c per lb. to 0.3c per lb. did Mr. Henry Chisholm see the necessity of making an improvement over the then existing method, always claiming when appealed to to make the necessary changes that they were doing well enough as it was. The 1.2c duty made importation of wire rods almost prohibitory, but on the reduction of the duty to 0.3c it was almost equivalent to free trade, and the consequence was that every wire rod mill in this country, except the Cleveland Rolling Mill Co.'s, was shut down, including those of the Washburn & Moen Wire Co., and all of the wire rods used, except for some few special qualities, were imported. Mr. Chisholm was the only manufacturer of wire rods in this country who made an effort to stem this tide of wire rod importation, and declared if he could not make wire rods as cheap or cheaper than imported rods he would close up his wire mill. At this stage consent was given and money provided for the changes necessary to make a 4-inch billet from an ingot and a wire rod from a 4-inch billet. To no one is the world more indebted for this than to Mr. Chisholm. And when we find that over 95% of the wire rods made in this country are made from a 4-inch billet and over 90% of the wire rods made in this country from the style of the mill he consented to have erected at that time, and that over 1,000,000 tons of wire rods are made each year, while over 2,000,000 tons more of 4-inch billets are being used annually for other purposes, we appreciate the far-reaching importance of the adoption of this size. It might be added that the above developments in the wire and wire rod industry led to Cleveland becoming the city in which more rods can be rolled and drawn into wire than in any other city in the world. That Mr. Chisholm was no figure-head in this matter is evident from the fact that he took a personal interest in the change, and the days were rare when he did not personally visit the works every afternoon.

Carnegie Steel Co. An enthusiastic Scotchman once remarked: "If all the scientific and noted men of the world were gathered together in one place and a man blind-folded and then given a stone to throw it would be 20 to 1 that he would hit a Scotchman." Be that as it may, were such a man to stand as above in any of the works of the Carnegie Steel Co. and cast the stone, it would hit a landmark in the history of rolling mills. The Carnegie Steel Co. has been making history from the first day Carnegie became connected with it, and is making history today. Such men as Schwab, Morrison, Corey, Gayley, McCrery, Berg and many others so prominently connected with this great corporation will have their names handed down as prominent landmarks in the history of iron and steel manufacture.

As I cannot touch in detail on the many landmarks this vast enterprise contains, I will here only say that a more perfect organization never existed for the manufacture of iron and steel from the days of Tubal Cain to the present time. And no company ever spent as much money for improvements as the Carnegie Steel Co. has spent during the last ten years. The founder of this concern is one of the greatest organizers and the best judges of men and the positions they are best qualified for the world ever saw. I have chosen him as the leading landmark in the history of rolling mills, and he stands head and shoulders above all others. The successes of his career, the results that have been accomplished under his guidance, both from a mechanical and a financial point of view, rival anything in the past or present of the world. He has scattered more money by way of improvements and has reaped a richer reward than ever known before. While paying the highest average wages to his employes he produced iron and steel at a lower cost, and then made a larger profit by doing so than any iron and steel manufacturer ever did before.

While neither he nor any of his ancestors are to be found among the first to sign the Declaration of Independence, Andrew Carnegie was the first man in the United States that was able to sign a declaration of independence of the protective duties upon iron and steel. Steel made by the Carnegie Steel Co. can be found in any part of the civilized world; and while it is an old saying that "the sun never sets on the British dominion," it could be truly said that the sun never sets upon the product of the Carnegie Steel Co. In the great consolidations that have taken place, which ultimately evolved into the United States Steel Corporation, and while the greatest amount of money was paid for the Carnegie interest, fabulous as this sum of money may seem, yet as a matter of fact the Carnegie interest today, even at this vast amount, is the best investment and the most remunerative property of the United States Steel Corporation. Looking back on Mr. Carnegie's career we find that where others utterly failed to make the iron and steel business remunerative he took hold of unproductive plants and made them a grand success. Notable among those is the Homestead Steel Works, built by some Pittsburg capitalist who failed to make it a success. Carnegie acquired this property, and today the Homestead Steel Works are considered not only the finest, but the best paying rolling mill plant in this country, and similar reference might be made to the Duquesne plant, which also was acquired, and is now owned by the Carnegie interests. Surely the name of Carnegie is entitled to live as the brightest among the shining landmarks by which we trace our rolling mill progress up to the present time.

But, after all, Mr. Editor:

Must every coral insect leave his sign
On each poor grain he lent to build the reef,
As Babel's builders stamp their sun-burnt clay
Or deem his patient service all in vain?
What if another sit beneath the shade
Of the broad elm I planted by the way,—
What if another heed the beacon light
I set upon the rock that wrecked my keel,—
Have I not done my task and served my kind?

* * * * *

The noblest service comes from nameless hands,
And the best servant does his work unseen.

AN AMERICAN ENGINEER IN ENGLAND.

Axel Sahlin was born and educated in Sweden, where his ancestors for several generations have been known as iron masters and mine owners. After graduating from the Stockholm Institute of Technology in 1877, he served his apprenticeship on the Swedish government railways and spent a short time as an inspector of railway material on the Continent and in England. He then came to the United States, where he was employed for a number of years with the Cambria Iron Co., at Johnstown, Pa. He afterwards was engaged with the Pottstown Iron Co., the International Ore Separating Co., and the Maryland Steel Co., being gradually promoted until he became general superintendent. He left this position to represent the Brown Hoisting Machinery Co. of Cleveland on the European Continent, and is at present general superintendent to the Millom & Askam Hematite Iron Co., Ltd., of Barrow-in Furness. Recently he has been in the United States as member of the commission of experts sent by the British Iron Trade Association to investigate and report on progress in the manufacture of iron and steel in this country.

Axel Sahlin.

Twenty-five Years of Engineering Progress in the Iron Industry.

By JOHN BIRKINBINE.

The advent of 1901 was signalized by numerous published comparisons, intended to indicate the progress of a century--comparisons, which, however carefully made, were in the nature of events combinations of personal knowledge and of a study of records prepared by others than the authors. Without questioning the authenticity of these records of a century's progress they are necessarily wanting in the details gained from personal knowledge, and cannot therefore encourage corrections or endorsements from those familiar with the conditions.

John Birkinbine.

Recalling how few are the evidences of development or activity which existed "one hundred years ago," that even in our older American cities the buildings which antedate 1801 are few, and that no person who, at the commencement of the nineteenth century, was old enough to notice details of industrial life, is living today, or if living, is in mental condition to recite these, then we realize what "one hundred years" means.

A very limited number who have passed the allotted span of three score years and ten are in position to compare in detail the progress made, either special or general, in a half century; for unless the person be unusually observant and before maturity become familiar with details, or like Mr. John Fritz, Mr. Jay Cook, or Mr. Abram S. Hewitt, in advanced life maintain activity and keep in close touch with the progress made, a record of 50 years must be at least in part hearsay evidence.

But the span of 25 years which has been suggested for this review comes within the personal memory of many still in business, to whom the world is indebted for much of the progress made, and who can verify, amplify or disprove statements made. This is particularly true of the iron and steel, the mining and transportation industries; for many of the men who have made the marvelous development possible are active today or if retired they are in position to criticise intelligently any statements offered. Hence a review of advances must be approached with the expectation that it will be spread before actors prominent in all specialties recorded.

A Few of the Engineers Who Have Come Up.

Toilers in subordinate positions, as mine boss, clerk, bookkeeper, furnaceman, chemist, draughtsman, assistant to engineers or to superintendent, about the year 1876, are now at the head of our largest enterprises. Their positions have been generally won by conscientious devotion to duty and constant study, and seldom by wealth or influential friends. The following, gleaned from personal knowledge, may serve as illustrations:

Mr. C. M. Schwab, president of the United States Steel Corporation, and the late active head of the Carnegie enterprises, entered the employ of the latter company as a junior member of the engineer corps.

Mr. James Gayley, first vice president of the United States Steel Corporation, late a managing director of the Carnegie Company, commenced business life as chemist for the Crane Iron Co., and Mr. W. R. Walker, second vice president, also started in the laboratory.

Mr. C. S. Price, general manager of the Cambria Steel Co., 25 years ago was a draughtsman in the Cambria offices; and Mr. Powell Stackhouse, president of this company, is another evidence of the advancement of a subordinate to the highest authority by periodic promotion.

The history of this plant also records the early work of the venerable John Fritz, whose name is inseparably linked with the Bethlehem Iron Works, of the late Capt. W. R. Jones, and of many others who achieved renown in iron and steel manufacture.

Mr. Don H. Bacon, managing director of the Tennessee Coal, Iron & Railroad Co., and W. J. Olcott, who manages the large group of Rockefeller mines, commenced work in minor subordinate positions in the mines of the Lake Superior Region.

Mr. Chas. H. Foote, vice president and manager of the Federal Steel Co., was superintendent of a blast furnace at the home of his childhood at Port Henry, New York.

Mr. T. W. Robinson, who as general manager of the Illinois Steel Co. directs an industrial army of 10,000 employes, commenced his labors in the Joliet laboratory of the company he now represents. A similar history covers the business career of his brother, Mr. C. S. Robinson, general manager of the iron department of the Colorado Fuel & Iron Co.

Mr. B. F. Fackenthal, president of the Thomas Iron Co., and Mr. E. S. Cook, president of the Warwick Iron & Steel Co., won the responsible positions they hold by faithful service in minor positions.

This list, far from complete, indicates that much of the progress made in the iron and steel industry is attributable to the recognition of those whose familiarity with the daily routine of operating plants has served as an excellent preparatory school.

The various departments of our large industries are managed by men who have elevated themselves from puddler, heater, laborer or hook up boy to be recognized throughout the country as model furnace, Bessemer, open-hearth or mill superintendents, and to these men much of the advance in product, in excellence and in uniformity is due. A number of the improvements which have encouraged such advance, and also reduced the amount and severity of labor required to produce the manufacturers of iron and steel, thus diminishing the cost per unit, must also be credited to these practical workers. The ideas of practical men and the studies of managers to accomplish greater and more economical results have been wrought out by engineer and mechanic, and applied so as to make possible the wonderful results which we chronicle.

A summary of the important improvements which have

JOHN BIRKINBINE, of Philapelphia, comes of a family of engineers. His father was chief engineer of the Philadelphia water department for 10 years and he received his early training in field engineering work and hydrographic surveys under his father. His technical and literary training was in the Polytechnic College of Philadelphia, and Hill School, Pottstown, Pa. Military service in 1863-4 and subsequent imperfection of the eyes interrupted his studies; then came two years of apprenticeship in a machine shop. His engineering career takes in a varied experience. For nine years he edited the journal of the United States Association of Charcoal Iron Workers, of which he was secretary. He has been for a number of years connected with the United States Geological Survey as the Government expert on iron ore and manganese ores. Maintaining an office in Philadelphia, Mr. Birkinbine has been called to most of the States, to Canada and to Mexico to examine and report upon iron mines, to advise upon the location of iron works, to construct new blast furnaces or to remodel older plants. More recently he has been consulting engineer of the Colorado Fuel & Iron Co. and the Cambria Steel Co. Mr. Birkinbine is president of the Franklin Institute, vice-president of the Manufacturers' Club and a member of the Engineers' Club, of Philadelphia. He has been twice elected president of the American Institute of Mining Engineers.

resulted in labor saving, fuel economy, large product and perfect material, demonstrates how great a proportion of these are to be credited to the practical and technical men who 25 years ago held inferior if not subordinate positions. To attempt a roll of honor would result in omissions to acknowledge merit, well-deserving notice, and an effort to mention the honored dead would be likewise incomplete. Even a list of prominent advances cannot be offered without danger of invidious distinction or of unintentioned omissions.

Our Status in Iron and Steel in 1876.

Twenty-five years ago, at the Centennial Exposition in Philadelphia, the products of the United States were, for the first time, placed in position for our people personally to compare them with the world's best; and profiting by a broadening of views, a more determined effort was made to excel the world in quantity and quality. Prior to this exposition few of those active in iron and steel manufacturing had visited kindred industries of the old world, but in the Centennial Exposition the products of Europe appeared side by side with our own, and processes and details were discussed with foreigners conversant with European problems, many of whom came as commissioners or members of the international jury of award.

The magnitude of the Krupp, Creusot, Bolckow-Vaughn, and other large industrial combinations were then marvels to most Americans and domestic establishments paled in comparison. We were occasionally familiar with the term "million," both as to capitalization and production, but "tens of millions" were unusual. Now "hundreds" and even "thousands of millions" of capital are lightly discussed, and our mineral resources are enumerated by hundreds of millions tons.

Electricity as applied for light or power was practically in the experimental stage, 25 years ago, and in no single feature is advancement so prominent to the average observer than in the general adaptation of electrical lighting about mills, shops, furnaces, and in some mines and in the liberal use of motors to haul mine cars and operate special mechanisms. Twenty-five years practically limits the time covered by the present commercial development of electricity for power and light. Compressed air has also been extensively adapted to rock drills, pneumatic tools, etc., and the installation of hydraulic equipments have been increased to an extent which could not have been anticipated.

Charles M. Schwab.

Some Contrasts in Production.

In the iron and steel industry the recognition of the influence of chemistry was spreading, and the association about 1876 with foreign specialists, such as Bell of England, Wedding and Ledebur of Germany, and Ackerman of Sweden, with our practical and technical men helped this recognition, while it gave to the foreigners an insight into the possibilities of America. We could be justly proud of our resources and of our development in 1876; which at that time impressed our foreign guests; but compared with today we were "humble folk." In 1876 the United States produced:

1,868,961 gross tons of pig iron.
368,269 gross tons of Bessemer steel rails.
1,347,562 gross tons of rolled iron.
19,188 gross tons of open-hearth steel.
469,639 gross tons of Bessemer steel ingots.

In 1876 the quantity of coal mined was 47,500,000 gross tons, and probably 4,100,000 gross tons of iron ore were mined. The imports of the latter mineral were 26,420 tons.

Comparing the above figures with those for 1900 we find 13,789,242 gross tons of pig iron, over seven fold increase in 25 years.

The world's production of pig iron in 1878 was estimated by Mr. James M. Swank at 14,262,174 tons, a quantity only about a half million tons larger than the output of the United States in 1900. The production of pig iron in the world in 1900 is estimated at about 40,400,000 tons, of which over one-third was contributed by the United States. Other products of the United States, in 1900, are:

2,383,654 gross tons of Bessemer steel rails.
3,398,135 gross tons of open-hearth steel.
6,684,770 gross tons Bessemer steel ingots.
240,235,966 gross tons of coal.
27,553,161 gross tons of iron ore mined, and 897,831 tons imported.

These figures show that:

The Bessemer steel rail production of 1900 was nearly seven times that of 1876, the Bessemer steel ingot output having been augmented fourteen times. The total production of steel in the world in 1900 is stated to be about 27,200,000 tons, of which over 37 per cent (10,188,329 tons) was manufactured in the United States. The country's production of steel in 1900 was two and two-thirds times greater than the entire world's output of 2,941,775 tons in 1878.

In the interval from 1878 to 1900 the open-hearth steel industry was developed from less than 20,000 to nearly three and a half million tons per annum, the United States in 1900 for the first time making more open-hearth steel than Great Britain.

Our production of coal in 25 years increased over five times, and we are now mining coal at the rate of about 700,000 tons every day in the year.

The iron ore output of 1900 was nearly seven times that of 1876, and in addition nearly 900,000 tons were imported.

The pig iron made, divided according to the fuel used, is shown in the following table:

PIG IRON MADE.

Fuel Used.	1876. Gross Tons.	1900. Gross Tons.
Anthracite	709,445	1,677,046
Bituminous Coal and Coke	883,937	11,727,712
Charcoal	275,579	384,482
	1,868,961	13,789,242

In 1876, 714 blast furnaces were considered on the active list, contributing in that year 1,868,961 gross tons of pig iron, while in 1900, 406 furnaces (not all of them active) had an output of 13,789,242 gross tons. In other words the output per existing furnace in 1876, was 2,618 tons, and in 1900 nearly 34,000 tons.

Twenty-five years ago we marveled at an annual product of over 30,000 tons, but today are not surprised at the record of 150,000 tons as the output of a single furnace in a year. More pig iron was made in the immediate vicinity of Pittsburg in 1900, than in the entire United States in 1876.

Changes in Respect to Fuel.

The extended application of coke as a fuel for smelting ores of iron is evident from the tabulated statement above, which indicates that a quarter of a century ago the use of anthracite was probably as great as that of coke; for in 1876 and for some years later a considerable amount of raw bituminous coal was mixed with the coke used, as today some

of the metal classed as made with anthracite coal is produced with mixed coke and anthracite. The denudation of available wooded areas and the limitations in assembling large amounts of charcoal at blast furnaces have prevented any considerable expansion in the output of charcoal pig iron.

Whether coke would have invaded the territory close to the Eastern Pennsylvania anthracite mines to as great an extent as is shown, had it been commercially possible to purchase smaller sizes of anthracite is open to question. But the demand for this hard coal for domestic and industrial uses places the selling rate above that at which bituminous coal can be mined, coked, and transported several hundred miles.

The open cellular coke structure permits of more rapid combustion than the dense anthracite; and as greater yield per furnace was desired it became a factor in comparisons of cost. The application of by-product ovens to coals which are too low in volatile matter to coke in bee-hive ovens may further advance the use of coke. These have already opened up new producing territory, and the erection of coking plants at furnaces removed from the coal supply is a late departure.

The low sulphur and phosphorus requirements for Bessemer steel, limiting the modicums of these elements in the fuel, have demanded close attention to the composition of coals, thus restricting the coke production in one district and developing it in others. In 1875 pig iron made with bituminous fuel took first place over that made with anthracite, charcoal having been superseded in 1869.

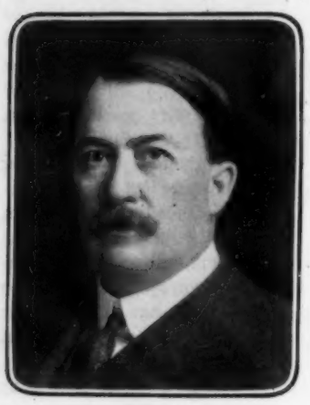
The period under review practically covers the application of the gas producer as a feature of open-hearth practice and for heating. It also includes the introduction of natural gas for mill furnaces, boilers, etc., and the history of its wasteful use, which in some localities resulted in practical exhaustion. The automatic stoker, and the extended employment of culm slack or undesirable sizes of coal may be included in the features of development, and the extended application of oil to furnaces and for tempering comes within the same limit.

Development in Iron Ore.

Twenty-five years ago the majority of the blast furnaces of this country had some local ores as their main dependence. Today most of the ores used are won from 500 to 1,000 miles from the furnaces smelting them, and in some instances nearby deposits are idle, while the distant ore is brought to the furnaces.

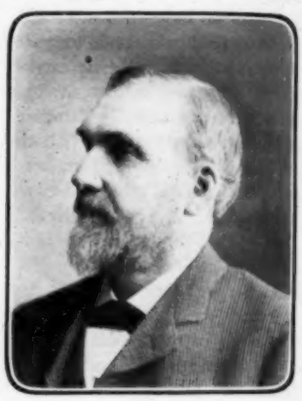
The reports of the Soo Canal show that in 1876, 609,752 net tons of Lake Superior iron ores passed the two locks each with nine feet drop, and that in 1900, 16,443,568 net tons (or 27 times the shipment of 1876) were passed through the three large locks, with a single lift of 18 feet now in use.

The record of the Lake Superior iron ore region which is tributary to the Great Lakes, shows that in 1876, 29 mines



Max M. Suppes.

Michael Baackes.



Edwin Reynolds.

MAX M. SUPPES, vice-president and general manager of the Lorain Steel Co., Lorain, O., was born in Johnstown, Pa., in 1856. He received a common school education and learned the machinist's trade. For about 10 years he was associated with R. W. Hunt at Troy, N. Y., at the Rensselaer Works, in the capacity of master mechanic, and had a great deal to do there with the development of the first automatic rail mill for rolling tee rails. Mr. Suppes became associated with A. J. Moxham, of the Johnson Steel Street Rail Co., at Johnstown, Pa., in 1888, as master mechanic and later as manager of the rolling mill department. Here he assisted largely in the development of girder rail rolling. In 1894 he was appointed general manager and placed in charge of designing and building the new plant at Lorain, O., which is operated by the Lorain Steel Co. Later the blast furnaces and ore receiving docks at the same plant were built under Mr. Suppes' direction. A number of devices of his invention are incorporated in the furnace plant as well as in the steel works.

MICHAEL BAACKES, of Cleveland, who has been called the father of the wire nail industry in America, was born in 1849 in St. Toenis, Germany. After receiving a college education and a thorough business training as a manufacturer, he came to the United States in December, 1874. In 1875, he started in Covington, Ky., the first wire nail works in this country, the firm being styled the American Wire & Screw Nail Co., with Mr. Baackes as general manager. He devoted several years of hard missionary work to putting life into the infant industry and succeeded in making the wire nail an industrial commodity by adapting it in improved form to purposes for which previously cut nails, tacks and wood screws had been used. In the fall of 1878, he made the first steel nails from Bessemer steel wire, furnished by the Cleveland Rolling Mill Co. for that purpose. This experiment being successful he removed to Cleveland in February, 1879, and became general manager of the HP Nail Co., members of the Chisholm family being his partners. This firm made from its beginning steel wire nails only, while all the nails in Europe and the United States, wire nails as well as cut nails and tacks, were yet made of iron. The favor found by the strong and handsome steel wire nails caused the HP nail works in a few years to grow into a large establishment. In 1889 Mr. Baackes founded the Baackes Wire Nail Co., being its vice president and manager. For this company he built in Cleveland, a model plant after his original designs, comprising rod mill, wire mill, nail and fence mills. It ranks today as one of the foremost for large production, economical handling and for earnings, among the mills controlled by the consolidation. In 1898 Mr. Baackes quit manufacturing and took up the profession of consulting engineer. He has built and remodeled eight rod mills in the United States and Europe, and gives his entire attention to designing and improving plants for making rods, wire and nails.

EDWIN REYNOLDS is a native of Connecticut and was born in Mansfield, March 23, 1831. He was apprenticed at 16 to the machinist's trade and in 1858 became superintendent of the shops of Stedman & Co., Aurora, Ind., builders of steam engines, pumps and sawmills. In 1867 he entered the employ of the Corliss Steam Engine Co. of Providence, R. I., and in 1871 was promoted to the superintendency, a position which he retained until 1877, when he associated himself with the late E. P. Allis in Milwaukee and began the development of his own inventions. The success of the Reynolds-Corliss engine led to Mr. Reynolds's permanent identification with the Edward P. Allis Co. Other successful improvements include the standard blowing engine, the steam ore stamp, the low-speed, direct-coupled type of engine and electric generator, etc. Mr. Reynolds has been a pioneer in the introduction of compound and triple expansion engines in power houses. Some years ago the University of Wisconsin conferred upon him the honorary degree of LL. D., and more recently placed his name on the frieze of its new engineering building.

shipped an aggregate of 993,311 gross tons of iron ore. Nine mines contributed over 50,000 tons each, the largest supplying 145,661 gross tons. The figures for 1900 were nearly 22 times as much, 106 mines shipping 19,059,393 gross tons, 71 mines contributing over 50,000 tons each, one being credited with over one and a quarter million tons and ten over 500,000 tons each.

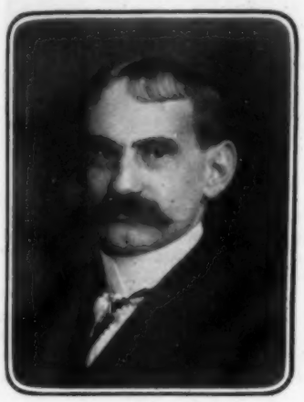
While this statement is not duplicated in any other section of the country, or in fact in the world, there has also been marked progress in Alabama and some of the near-by States where the juxta-position of large deposits of iron ores, coking coal, and limestone have built up an important industry.

In the absence of data concerning iron ores those for pig iron can be used for comparisons. The group of States, Alabama, Georgia, Tennessee, North Carolina and Virginia produced in 1876, 65,421 long tons and in 1900, 2,066,128 gross tons. Outside of the Lake Superior region there were 33 mining operations which produced over 50,000 tons in 1900, and one contributed over one million tons. One important mine in the Cornwall ore hills of Lebanon county, Pennsylvania, has been exploited since the year 1740, but of the sixteen and one-third million tons of ore taken from this deposit, eleven and three-quarter millions were mined in the last twenty-five years.

In the interval covered by this review several efforts to establish iron industries in the Western and Central part of the Continent were made; but one of these has survived to become an important factor in the steel trade, by smelting excellent ores assembled from Colorado, Wyoming and New Mexico with Colorado coke. The plant of the Colorado Fuel & Iron Co. is now ranked as one of the large works of the country.

It is probable that the utilization of economic mining methods and appliances, and the rapid development of the open hearth steel industry, will combine to encourage the revival of some of the Eastern ore deposits which have lain unwrought, or which have been small producers; but the 700,000,000 tons in reserve in the Lake Superior region may be expected to continue for some time the source of supply for the bulk of the ore used in American blast furnaces. This will be due fully as much to the mining, handling and transportation facilities as to the character of the ore; for in mining methods, means of transportation and appliances for handling material cheaply the great volume of ore, the Lake Superior region has been in the van and to compete with it similar economies must be followed.

The enormous development of the Bessemer steel industry created a demand for low phosphorus ores, and the limitations placed upon this element were gradually narrowed so that some ores otherwise desirable have found a restricted market. But it is probable that this will be materially expanded in the near future.



T. W. Robinson.

F. H. Treat.

Thomas McDonald.

T. W. Robinson, general manager of the Illinois Steel Co., was born in Boston in 1862. He entered the Massachusetts Institute of Technology in 1880 and graduated as mining engineer in 1884. In 1885 he entered the employ of the Joliet Steel Co. as assistant in the chemical laboratory, worked up to the position of chief chemist and had charge of the laboratory for two and one-half years under H. S. Smith, then general superintendent. After a study of the iron and steel plants abroad and shortly after the formation of Illinois Steel Co., he became superintendent of the Bay View blast furnaces at Milwaukee. Upon the formation of the Colorado Fuel & Iron Co. in 1892, he assumed the general superintendency of the Pueblo plants. After a connection of seven years with the Colorado company he again became associated with the Illinois Steel Co. as general superintendent of the Joliet plant in the summer of 1889. Six months later he was made general manager of the Illinois Steel Co. upon the resignation of his predecessor, E. A. S. Clarke.

F. H. Treat, manager of the South Side plants of Jones & Laughlins, Ltd., Pittsburg, Pa., was reared on a farm in Illinois. At an early age he displayed a talent for mechanics and at the age of fifteen he graduated from the high school at Joliet, Ill. After attending a commercial school for a year he entered the office of A. J. Mathewson, C. E., a surveyor and civil engineer well know in Northern Illinois. After serving an apprenticeship of two years he developed a taste for the steel business, and in 1875 he entered the works of the Joliet Iron & Steel Co., Joliet, Ill., as an apprentice. He was soon given a position in the draughting room and later was attached to the engineering department of the works. For 15 years he was in the employ of the company and during that period designed much of its automatic machinery. To Mr. Treat is due the automatic rolling of rails in multiple lengths as first practiced on a three-high mill. This rail mill was first placed in operation in 1885 at the Joliet plant, although a working model one-fourth size, was successfully operated in 1883. As engineer Mr. Treat was associated with William Garrett in the construction of the Joliet rod mill. He also designed a billet conveyer which was later installed at the plant of the Carnegie Steel Co., Duquesne, Pa. In 1889 he became associated with the Allegheny Bessemer Steel Co., Duquesne, Pa. (now owned and operated by the Carnegie Steel Co.), as superintendent. In 1890 he resigned to accept the position of superintendent of the North Works of the Illinois Steel Co., Chicago. He remained in this position until 1896 when he became superintendent of the Cleveland Rolling Mill Co., Cleveland, O. He held this position until April, 1900, when he was appointed consulting engineer for Jones & Laughlins, Ltd., and was later appointed manager of their entire South Side plant.

Thomas McDonald was born in Allegheny county, Pa., Nov. 11, 1848. He left school at an early age and at 20 started to learn the carpenter's trade, at which he worked for about seven years. He accepted in 1876 the position of weight-master at the Edgar Thompson Works, where he worked until 1880, when he was promoted to turn foreman of the converting mill. In 1884 he was made night superintendent of this department, which position he occupied until 1889, leaving then to take charge of the converting mill of the Allegheny Bessemer Co., which was later purchased by the Carnegie Steel Co., the plant being known as the "Duquesne Works." In February, 1893, he severed his connection with this company to become general superintendent of the Ohio Steel Co., of Youngstown, O., whose works were built under the direct supervision of Mr. McDonald. It was the original intention to build a converting and blooming mill to make 4-inch billets for the local mills. Mr. McDonald, foreseeing the possibilities of the tin plate and small billet trade, proposed the installation of a separate mill for rolling sheet and tin bars, and also billets from 1½ up to 4 inches. The industrial depression made it very difficult to get the local capitalists to make any further investments, but Mr. McDonald finally succeeded in getting them interested in this project and the results more than justified their confidence in

In 1876 the states of New York, New Jersey and Pennsylvania produced slightly over 1,000,000 gross ton of pig iron using local ores, and in 1900 these states supplied over 68 million tons of pig iron, much of the iron ores being either brought from the Lake Superior region or imported.

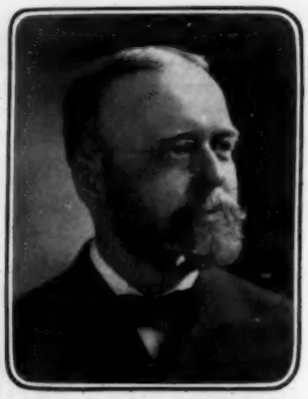
Cars of 50 tons capacity drawn by consolidation locomotives have displaced five and ten ton cars, moved with what would now be styled "dinkey engines." Immense docks with pockets load more ore into a vessel in an hour than 25 years ago could be placed in a day; and the grabs, cantilevers and whirlies produce similar savings in discharging, etc. The steam shovel has taken the place of pick and hand shovel in open pits, while electricity and compressed air have revolutionized underground exploitations, and mechanical appliances have made possible outputs and costs which would have been visionary two decades ago.

This sketch cannot be extended to describe how the ore brought from the mines in large cars is quickly fed into bins, or how a number of these bins are simultaneously emptied into the hold of a 6,000-ton vessel, whose modern equipment permits of speed such as brings its cargo to the lower lake port after a brief voyage. Nor can it enter into the detail of the unloading devices which have eliminated to a great extent stevedore charges, or of the car dumpers which make possible a short stay in port.

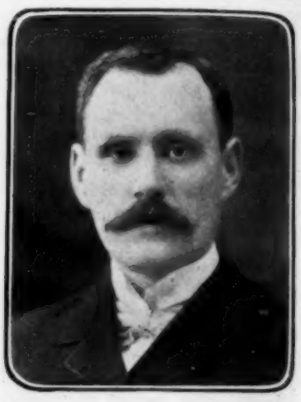
Blast Furnaces.

The details of construction and equipment of a modern blast furnace plant have developed enormously in the past quarter of a century. The furnace stacks average considerably greater height, and the diameter of hearth and bosh have increased, giving greater cubic capacity. But about 1876 there were individual instances of blast furnaces in Europe whose

Julian Kennedy.



C. E. Stafford.



Nevin McConnell.

his judgment. The Ohio Steel Co.'s plant began operations in February, 1895, and in the first eleven months turned out 166,501 tons of steel; in 1899 the record was 525,419 tons. Since that time there have been added three large blast furnaces, a continuous mill, and also a rail finishing mill. The remarkable growth and success of this works is very largely due to the strong individuality of Mr. McDonald.

JULIAN KENNEDY, long recognized as one of the leaders in American mechanical engineering circles, was born in Poland township, O., in 1852. He is a son of the late Thomas Walker Kennedy, designer and constructor of blast furnaces. At the age of 17 Julian Kennedy entered the employ of the Struthers Iron Co. as draughtsman, also serving as engineer for blowing engines and other machinery. In 1872 he entered the Sheffield Scientific school of Yale College, studying civil engineering and later chemistry. After graduating he was an instructor in physics during 1875 and 1876, and taking at the same time a post-graduate course in chemistry of iron and steel, together with a special course in higher mathematics and astronomy. In 1875 he won the inter-collegiate championship for single sculls at Saratoga lake, and was a winner in 14 out of 18 important races. In 1876-77 Mr. Kennedy was superintendent of blast furnaces of the Briar Hill Iron Co. at Youngstown, O., superintendent of the Struthers blast furnace, Struthers Iron Co., Struthers, O., in 1877-78; superintendent of the Morse Bridge Works, Youngstown, O., 1878-79; 1879 to 1883 superintendent of blast furnaces of the Edgar Thomson Works, Braddock, Pa.; superintendent of the Lucy Furnaces, 1883-85, and general superintendent of Carnegie, Phipps & Co. from 1885 to 1888. In 1888 he became chief engineer of the Latrobe Steel Works, having charge of the construction of those works. In 1890 he opened an office in Pittsburg, as a general consulting and contracting engineer and has since been connected with nearly every important steel works in the United States, besides doing a great deal of engineering work in England, Germany, Austria and Russia. Mr. Kennedy has taken out a large number of patents which are in successful use, nearly all in connection with the manufacture of iron and steel, and has frequently acted as an expert in important patent litigations. Prominent among his inventions are his improvements on hot blast stoves, blast furnace filling devices, improvements in blowing engines, reversing engines, blooming mills and manipulators and special machinery for hammering and rolling locomotive tires, which have all gone into use very largely throughout the country.

C. E. STAFFORD, who has been prominent in the development of the open-hearth process in the United States, was born in Plymouth, N. H., Jan. 31, 1854. He took the degree of S. B. in mining and metallurgy at the Massachusetts Institute of Technology in 1873 and for a year after was instructor in the metallurgical laboratories. He was chemist for several companies at Wyandotte, Mich., in later 1874, and early in 1875 became connected with the Pennsylvania Steel Works as chemist. Soon after he was put in charge of the open-hearth department. He improved the design of the open-hearth furnaces by radical modifications of the ports and roofs, giving to the latter the steep pitch, which soon became an almost universal feature in American open-hearth furnaces. These changes caused much more intense combustion, resulting in increased production of ingots at a much lower fuel consumption. In 1880 he designed and put in operation two 30-ton furnaces, at that time the largest in the world. These had many unique features and continued in operation till 1900, with some modifications by his successor, H. H. Campbell, the well known metallurgist, now general superintendent of the Pennsylvania Steel Co. These furnaces were remarkable for the extremely low oxidation of the charge. The removable or portable ports, much used in connection with both the Wellman rolling and the Campbell tilting open-hearth furnaces, were originated by Mr. Stafford. In 1880 he became superintendent of the Bessemer converting department and by him was made the first regular basic or Thomas Bessemer steel ingots in this country. The old or No. 1 Bessemer was used for this purpose. Satisfactory steel was made from the beginning, but commercial conditions were such that the company did not deem it wise to go ahead with a modern and adequate plant. Subsequent history has proved the wisdom of the decision.

It is interesting to note that E. C. Felton, president, and H. H. Campbell, general superintendent, of the Pennsylvania Steel Co., and F. W. Wood, president of the Maryland Steel Co., were his associates and pupils. Resigning his position at Steelton, Mr. Stafford from 1885 to 1901 was connected in turn with the Shoenberger Steel Co., Pittsburg, where he designed the company's Bessemer plant, and the Illinois Steel Co. He went to South Chicago in 1896 to take charge of the open-hearth and plate departments, which reached under him a successful development. In July, 1901, he was called to the presidency of the Tidewater Steel Co., Chester, Pa., which under his leadership is becoming a strong factor in the plate trade of the Eastern coast. He has been a member of the American Institute of Mining Engineers since 1873.

NEVIN MCCONNELL got his first experience in the manufacture of steel at the open-hearth plant of the Steel Co. of Scotland, at Hallside, going to them in 1880. In 1886 he came to this country and obtained a position with the Shoenberger

bosh diameter exceeded that of any now active, and the height of some furnaces closely approached that of the tallest now in operation. Few of these large furnaces proved successful at that time and general American practice approved of a range in size of 16 to 20 feet bosh diameter, and 65 to 80 feet height for mineral fuel furnaces, although a number of smaller stacks operated satisfactorily and with good returns to their owners.

Within the last decade the tendency has been to augment the dimensions of furnaces, and crucibles 12 to 15 feet diameter and boshes 18 to 22 feet diameter are found in stacks whose height ranges from 85 to 105 feet.

Following the advance in chemical knowledge which has been referred to, the tendency of blast furnace management has been to augment the output, and to make such result possible, there have been improvements in the power and economy of equipment, such that an individual stack, which at the present time would be considered modern, costs from three to five times as much as one that was similarly rated in 1876, while the output has been augmented in even grater ratio. The increase in expenditure has been an important factor in reducing the number of individual owners of blast furnace plants and in increasing the corporate control. A plant which for each furnace requires an outlay approximating three-fourths of a million, and may exceed one million dollars, and which demands the control of fuel and ore supplies does not invite individual or partnership ownership.

The material changes are in the increase of the power of machinery, both as to quantity of blast supplied, and the pressure and temperature at which it is delivered. The use of condensing and compound engines, many with positive motion valves, the application of water tube boilers, the increase in

Walter Kennedy.

Peter Patterson.

Victor E. Edwards.

Steel Co. In March, 1888, he went to the Homestead plant of the Carnegie Steel Co., becoming superintendent of open-hearth plant No. 2 in July, 1891, and both open-hearth departments in 1892. Believing that a radical change in the principle of operating open-hearth furnaces was necessary, he presented his plans to the Carnegie Steel Co., which were put into operation at the beginning of 1895. This put the operating of open-hearth plants practically on a par with the Bessemer process, and brought the cost of operating down to such a point that the development in the open-hearth process has been rapid. In 1895 four new furnaces were added to the No. 2 plant, under his direction, and in 1896 he remodeled the eight furnaces at this plant. In 1897 the No. 1 plant was also remodeled under his direction. He then designed and built the first 10 furnaces in the No. 3 plant, until recently considered the most modern in the United States. Mr. McConnell was associated with Mr. Schwab and Mr. Corey in the manufacture of the nickel armor plate at Homestead, and was one of two representatives of the Carnegie Steel Co. sent to the Krupp works to acquire the process. In March, 1898, he severed his connection with the Carnegie Steel Co. to become general superintendent of the Buhl Steel Works and the Sharon Iron Works at Sharon, Pa. When the Buhl Steel Works were sold to the National Steel Co., Mr. McConnell was retained as general manager, but in 1899 he became associated with Mr. Buhl and others in organizing the Sharon Steel Co., being appointed general manager of the steel plant, including the blast furnace, open-hearth and blooming mill departments, also a member of the board of directors and executive board. Recently he resigned from the company.

WALTER KENNEDY was born in Poland, Ohio, in 1861, and was early apprenticed to blast furnace building, his father being the late Thos. W. Kennedy, well known as a blast furnace designer. Advancing rapidly, his first occupation was with the Carnegie Steel Co., where he made a thorough study of chemistry and occupied various positions until he was made superintendent of the Lucy furnaces, a position he held for three years. In 1889 he became connected with the Moorehead-McClain Co., later manager of the Jefferson Iron Co., Steubenville, O., and in 1891 became superintendent of the Buffalo Furnace Co. Mr. Kennedy later opened offices in Pittsburg as a consulting engineer. In 1897 the late Senator Calvin S. Brice, J. Pierpont Morgan, Senator Washburn and others engaged Mr. Kennedy to go to China in the interest of expected concessions for railroad building. Owing to the death of Mr. Brice, this plan was abandoned and Mr. Kennedy remained in China in the employ of the Chinese government, to take charge of mining and metallurgical work. He was appointed first secretary of the Chinese Imperial Railway; technical director and general manager of the iron and steel works located at Han Yang and in a similar capacity at the mint and arsenal at Wu Chang Fu, his work being commended by the governments at Pekin and at Washington. Returning to the United States two years ago, Mr. Kennedy again took up his work. He is vice-president and consulting engineer of the Empire Steel & Iron Co. of New York; consulting engineer of the Sharon Steel Co.; designing engineer of the Roane Iron Co., Rockwood, Tenn., and engineer for the Cramp Ontario Steel Co., Collingwood, Ont.

PETER PATTERSON, consulting engineer to the National Tube Co., was born in Jedburgh, Scotland, May 12, 1842. He was educated in the public schools, learned the trade of machinist, and spent several years in some of the best shops in Edinburgh and Glasgow. He came to this country in 1866 and first located in Norwich, Conn., then moved to New York and was employed for several years in the Secor Iron Works. In 1871 he accepted a position with the National Tube Works Co., of Boston, Mass., and in 1872 was sent to McKeesport, Pa., as foreman machinist to take charge of the erection of the new pipe mills then being built. He also assisted in constructing the National Rolling Mills in 1889. In 1880 he was appointed superintendent of the National Tube Works Co. and held that position until 1897, when he was appointed consulting engineer. He designed and constructed the United States Seamless Tube Co.'s plant at Christy Park, Pa., a department of the National Tube Co. Mr. Patterson is the inventor of the movable draw bench, the back charging method of making butt weld pipe and other valuable devices, and was the first to use electric power for operating rolls for welding pipe. He is a member of the Engineers' Society of Western Pennsylvania.

VICTOR E. EDWARDS, mechanical engineer for Morgan Construction Co. of Worcester, Mass., was born in Massachusetts 39 years ago. He graduated from the Worcester Polytechnic Institute in 1883. For seven years after this date he filled engagements with Merrimack Mfg. Co., Deane Steam Pump Co., Washburn & Moen Mfg. Co., Holyoke Machine Co., Simons Rolling Machine Co. and Otis Steel Co. The past eleven years has been spent with Mr. Charles H. Morgan, and since its incorporation with Morgan Construction Co., of which firm Mr. Edwards is a member. Mr. Edwards has been closely identified with all recent advances in continuous rolling and is perhaps best known as the inventor of the Edwards flying shear for cutting hot billets while in motion. Devices of his design for handling finished material, as merchant bar, hoops and cotton tie, have been adopted on a large scale. Machinery for wire drawing plants has also received close attention, his inventions covering a

diameter, height and permanent construction of hot blast stoves, liberal expenditures for bosh and hearth cooling appliances, especially those made of bronze and copper, located in thin walls, have been features of later furnace construction. Familiarity with present furnace equipments fails to suggest that the first installation of Whitwell fire brick hot blast stoves in this country was in 1875.

The interior shape of the blast furnace passed through various changes in the 25 years under discussion. The boshes were steepened until a "no bosh furnace" was attempted. Then a reaction towards high crucibles and flat boshes was followed by the compromise which prevails at present.

A radical departure has been in the crucible diameter, which has been enlarged as the increased pressure possible from improved appliances was used, blast furnace managers realizing that the output of a plant is practically dependent upon the quantity of fuel which can be advantageously consumed in the crucible.

Following the study of the economical smelting of ores came the investigation of more cheaply handling the increased quantities of material required in producing pig iron, and in removing the metal made. The former has resulted in the development of systems of storage yards, coke piles, bins for stock, etc., and the discharge of stock through chutes in the bins which receive the ore, fuel, and flux, from dump bottom cars. These in turn feed mechanically drawn scale cars which discharge into a skip car. This traveling over an inclined bridge, dumps the material through a bell and hopper into the furnace, in such manner as to secure uniform distribution, keeping a close seal on the gases.

The economy in handling pig iron has been by casting the metal into bars longer than the ordinary sized pig, and by passing these bars or the ordinary pigs and sows through mechanical breakers in the casting house. But to a greater extent the molten metal has been run into cars holding from 10 to 20 tons of the liquid material, which are conveyed to mixers or reservoirs connected with steel plants, or which are taken to casting sheds or to feed machines in which the iron is cast into a series of traveling molds of convenient size for handling and shipping.

Crude blowing engines, even some wooden blowing tubs operated by water-wheels, were still in existence in 1876 at a few plants, and the long stroke horizontal and vertical steam engines, with flap leather valves, were the prevailing type. A feature of the Centennial Exposition in 1876 was a short stroke, high speed blowing engine exhibited by the Weimer Machine Works, the valves being of leather working upon iron girds; and since that date greater piston speed in blowing engines has been the rule, particular attention being paid to the difference between valve and piston areas, and the elimination of slush room. The bull type of engine has been supplanted by a combination of horizontal and vertical parts and by steeple engines, some of which are arranged on the cross compound principle. Some of the latest editions, however, are of the horizontal type throughout.

Several of the nine blast furnaces connected with the Carnegie plants, have made remarkable records, the most interesting of which is probably that of Furnace H, which in a continuous campaign of over seven years is credited with an output of more than 1,000,000 gross tons. The stack is still in operation, and its manager anticipates that 1,500,000 tons may be produced before the stack requires relining. This furnace is

S. V. Huber.

John McGeorge.

John C. Cromwell.

number of important devices in this class of work. He is a member of the American Society of Mechanical Engineers.

AFTER RECEIVING a thorough technical education in the polytechnic school at Zurich, Switzerland, Sigismund V. Huber of the firm of S. V. Huber & Co., Pittsburg, emigrated to America. For ten years he was chief engineer of the Reading Iron Works, Reading, Pa. He then accepted a position as engineer with the Lloyd-Booth Co. of Youngstown, O. Several years ago he embarked in business for himself as a consulting engineer and has been eminently successful. Among the plants which he has designed and erected are the Bessemer plant of the Republic Iron & Steel Co., Youngstown, O.; the open-hearth plant of the Minnesota Iron & Steel Co.; a continuous skelp mill for the LaBelle Iron Works of Wheeling, W. Va.; the Buhl plant of the National Steel Co., New Castle, Pa. At present he is engaged in erecting a blast furnace plant for the Pioneer Mfg. Co. at Birmingham, Ala., as well as the entire new plant of the Youngstown Iron Sheet & Tube Co., Youngstown, O. He is the inventor of many appliances for the rolling of iron and steel products.

BORN AT Manchester, Eng., in 1852, John McGeorge was early apprenticed to the machinist's trade and in 1873 became a draughtsman at Galloway's, the Manchester engine builders. Later he was connected with Deakin, Parker & Co., engine builders, as draughtsman and general manager, and in turn with a number of large machinery manufacturers. In 1885 he came to the United States, designing and constructing the plant of the Bellaire Stamping Co. at Bellaire, O. At Washington, Pa., he designed and built glass works and glass works machinery, going in 1887 to Pittsburg, where after a short connection with Henry Aiken, he became engineer for the Pittsburg Iron & Steel Engineering Co. He left that concern in 1889 to accept a position with the Wellman Steel Co., Thurlow, Pa., and when the Wellman-Seaver Engineering Co., of Cleveland, was organized, became its chief engineer, a position he now holds. He is vice-president of the Electric Controller & Supply Co.

J. C. CROMWELL is a native of the Blue Grass State and was born in Frankfort in 1866. He received a public school training and then entered the Illinois University at Champaign, graduating in 1886 from the school of engineering. Upon the organization of the Bates Machine Co. in 1888, Mr. Cromwell became chief draughtsman and served in that capacity until his acceptance of a like position with the Illinois Steel Co. at Joliet. In company with Messrs. Garrett and Lash he formed the Garrett-Cromwell Engineering Co. in March, 1887 and is treasurer of that organization. His mechanical training in the practical details of an extensive and progressive steel plant enables him to grasp readily the present day problems in manufacturing handled by his firm. Its high repute has been maintained in no small degree by that class of technical ability of which Mr. Cromwell is representative.

EDWARD E. ERIKSON, contracting and consulting engineer of Pittsburg, is a native of Stockholm, Sweden. He received his technical education at the Swedish Government Technical School, and for five years served as an apprentice, acquainting himself with the manufacture of iron and steel. In 1882 he came to this country and secured employment in the shops of the Pennsylvania Railroad Co., at Altoona, Pa. Later he

90 feet high, with a bosh diameter of 20 feet, and a hearth diameter of 13 feet.

No. 7 Furnace of the South Chicago plant of the Illinois Steel Co., now part of the United States Steel Corporation, is 85 feet high, 20 feet 9 inches bosh, with a 13 feet hearth. It went into blast Jan. 20, 1891, and has been out but once since for a short time to make some minor repairs. On June 28, 1901, it passed a product of one million tons and the furnace is still in operation, averaging over 325 tons per day with fuel consumption of about 1,900 pounds of coke per ton of iron. No. 8 furnace of the same plant was blown in July 28, 1894, and up to October 1 had produced 775,000 tons of pig iron. This furnace is 85 feet high, 19 feet 6 inches bosh, 12 feet 6 inches hearth and gives promise of continued operation. Records such as these should effectually dispose of the English contention, so often made, that the rapid driving of the American blast furnaces, as compared with those of the English, produced in the aggregate less metal from a single lining. It is doubtful if any other furnaces in the world have produced as much pig iron without relining as those named.

Mr. Charles Kirchhoff as president of the American Institute of Mining Engineers in 1899 made some interesting comparisons of cost of producing pig iron from 1889 to 1898. He showed that in 1898 at a Southern plant

The average production had increased	67.7	per cent.
The coke consumption per ton of metal had decreased	8.8	" "
The labor cost has been reduced	48.1	" "
The average selling price had declined	38.8	" "
That at an Eastern plant the production was augmented	63.3	" "
The fuel consumption reduced	3.	" "
The labor cost fell	38.9	" "
And the selling price declined	37.	" "

A third record in the Pittsburg district was:

Reduced labor cost	54.	" "
Reduced cost of raw materials	56.	" "
Reduced coke consumption	14.	" "

If similar comparison could be made for the period under review decidedly greater advance would be indicated.

Steel Works Progress.

In 1876 eleven Bessemer steel works produced 525,096 net tons of steel ingots, and 412,461 net tons of rails, while in 1900, 6,684,770 gross tons of Bessemer steel ingots and 2,383,654 tons of Bessemer steel rails were made.

The records of the Cambria Works at Johnstown, Pa., illustrate some interesting phases of development in the steel industry. The Bessemer plant of this works, which started in 1871, consisted of two five-ton converters, which in 1876 produced 64,000 tons of ingots; but the same converters, with minor modifications, turned out 216,000 tons in 1888, the year preceding the disaster which by flood crippled the works. The new plant of four ten-ton converters (only three of which are in contemporaneous service) produced in the first full year, 1890, 243,000 tons, and ten years later, 1900, made 476,000 tons of ingots. In 1876, jib cranes, supplemented by hooks, operated by the roll gang laborers, handled the 1,400 pound ingots, today electric cranes and feed tables, with fewer operatives, convey the 7,000-pound ingots to the heating furnaces and the blooming mill. In 1876 a double length of 60-pound rail was the practical limit of the roll train. In 1900 four lengths of 85-pound rail was not an unusual product from a single billet. It was at this works that the first three-high roll train was

E. E. Erikson.

Jno. M. Hartman.

M. A. Neeland.

accepted a position in the engineering department of the Pittsburg, Fort Wayne & Chicago railroad at Pittsburg, and for a number of years afterward was associated with J. P. Witherow at New Castle, Pa., as an assistant. Resigning this position he went with the firm of Lean & Blair, contractors for glass and steel furnaces, as chief engineer. He was associated with Mr. Blair in the development of the Adams-Blair direct steel process, which, however, did not prove a success. Severing his connection with this firm he embarked in business for himself and has designed and built many tin and sheet plants throughout the country. At the present time he has charge of the erection of the bulk of the tin plate and sheet plants independent of the consolidations.
solidations.

JOHN M. HARTMAN was born in Chester county, Pa., in 1840. He served an apprenticeship as machinist and mechanical engineer with I. P. Morris & Co., Philadelphia. In 1866 he designed and constructed the Anvil Furnace at Pottstown, Pa.; in 1867 the Saucon Furnace, Hellertown, Pa.; in 1868, the Keystone Furnace, the Oxford Furnace, at Oxford, N. J.; the Coleraine Furnace at Reddington, Pa., and other plants. In 1878 he designed and constructed the A, B and C furnaces of the Edgar Thomson plant, and in 1880 designed the furnace of the Colorado Iron & Steel Co., and the Oregon Iron & Steel Co. He has been steadily engaged since in building furnaces and remodeling other plants. In the improvement and invention of furnace equipments and accessories he has been conspicuous. The Siemens Cowper fire brick stoves were introduced by him in 1877; he also perfected and successfully used in 1876 the closed front or cinder notch, which up to that time had been a failure. He has always been an advocate of powerful blowing machinery and the fast driving of furnaces. He has strongly urged the more careful and watchful running of furnaces, believing that the difficulties that furnaces get into are always traceable to neglect somewhere and that with more rapid driving men of more skill and patience are required for sucessfully operating them.

M. A. NEELAND is best known as a designer of blast furnace plants, but his experience has included also the building of a large amount of rolling mill machinery. From 1891 to 1898 he was chief engineer of the Duquesne Works of the Carnegie Steel Co., and designed the Duquesne blast furnaces in 1895. In 1898 he became chief engineer of the Ohio Steel Co.'s works at Youngstown and designed the blast furnace plant there. During 1900 Mr. Neeland was chief engineer of the National Steel Co. and designed the blast furnace plants for the New Castle Works and a large plant for the Mingo Junction Works. The Duquesne furnaces began a new era; they were the first having a complete and comprehensive system of handling the raw materials from the railroad yards to the furnace top. This improvement was a necessity because of the large size of the furnaces. They were probably the first furnaces designed for a daily capacity of 500 to 600 tons and on account of the new mechanical appliances the labor cost of production was cut 50 per cent. The later furnaces designed by Mr. Neeland contain improvements on the Duquesne plant, the chief aim, however, being to obtain a furnace plant having about the same capacity at a much less first cost of construction, without sacrificing any of the labor economies. On January 1, this year, Mr. Neeland took charge of the William Tod Co. of Youngstown, O., manufacturers of engines for iron and steel works.

erected in 1874, and the first reversing engine, of English make, was transferred from the Freedom works to the Cambria plant about the same time.

Ponderous reversing engines and massive mill engines, of superb design and high economy, the products of American mechanics, are common features of the large steel works and rolling mills.

In 1875 the Bessemer plant and rail mill of the Edgar Thomson Steel Works was put in operation, with a capacity of 375 gross tons of rails per day, when running double turn. This works, now part of the Carnegie property, transferred to the United States Steel Corporation, has produced 75,000 gross tons of ingots, and 62,000 gross tons of steel rails in a month. On September 23, 1901, the converting mill made a total of 3,391 tons of ingots in 24 hours. The blooming mill 2,980 tons of ingots bloomed in 24 hours. One rail mill supplied 2,730 tons of finished rails in 24 hours.

Mr. Kirchhoff's comparison of the cost of producing Bessemer steel ingots from 1891 to 1898 demonstrates a decrease in labor cost of 25 per cent., and of total cost of 36 per cent., and instances a large Pittsburg plant where in the interval the cost of conversion in 1897 was but 52 per cent. of what it was in 1891. A more remarkable comparison is that the product of a wire rod mill in 1898 was 3¼ times that of 1889, while the cost of rolling was but 63.6 per cent.

Mr. James M. Swank, in his admirable article on "Iron and Steel at the Close of the Nineteenth Century," says that the first wire nails were made in this country in 1875, while in 1874 in Pennsylvania natural gas was used for the first time as fuel in the manufacture of iron, for six months furnishing all the fuel required for puddling and heating furnaces, as well as for the boiler. The first basic steel is said to have been made in this country in 1884, but the process was not commercially successful until 1888. The first contract for American made armor plates was in 1887 for 6,700 tons, but the armor plate itself was not produced until the year 1890.

Records of a similar character could be multiplied and details given of continuous mills, soaking pits and gas heated furnaces, powerful mill trains, about which a smaller number of men are employed in fabricating a ton of material than were necessary to produce a hundred weight in 1876.

The growth in size of open-hearth and heating furnaces, the use of mechanically and electrically operated charges and cranes, the development of conveyors for hauling billets, the utilization of hydraulic presses of enormous size, in forging large masses, such as armor plate and guns, all are evidences of the progress in iron and steel metallurgy in a quarter of a century.

The period under discussion covers a marvelous increase, not only in total quantities, but in sizes of units. Larger ingots, billets and slabs, have produced thicker, wider and longer sheets, deeper and heavier I beams, channels, angles and other shapes, heavier sections and longer rail lengths, all of which require larger furnaces and ladles, more powerful machinery and cranes, greater steam producing capacity, heavier roll trains, elaborate handling appliances, all of which while increasing the output have decreased the cost of production.

An interesting feature of development which is in the limit of the period named, is the production of large ordnance projectiles, and the building up of an important armor plate industry, which with the development of the ship building industry has practically made the United States independent in this speciality.

The Griffin Wheel Co., Chicago, has had plans prepared for a new foundry to be built at 262-272 North Sacramento Ave., Chicago.

C. H. Wellman.

John W. Seaver.

T. R. Morgan.

CHARLES H. WELLMAN was born June 12, 1863, at Nashua, N. H., where his father was superintendent of the Nashua Iron Co. He left home in October, 1881, and secured a position at the works of the Morgan Engineering Co., at Alliance, O., serving his time as a machinist and draftsman. In 1885 he became chief draftsman at the Otis Steel Works in Cleveland, and in a few months was given charge of the open-hearth department. In January, 1890, he resigned and moved to Thurlow, Pa., where he was made superintendent of the Wellman Steel Co. He left there in 1895, having been appointed open-hearth superintendent of the main works of the Illinois Steel Co., of South Chicago, which had just been completed. He filled that position until the organization of the Wellman-Seaver Engineering Co., when he returned to Cleveland to take an interest in the business and to become engineer and general manager of that organization.

JOHN WRIGHT SEAVER, vice-president of the Wellman-Seaver Engineering Co., was born in Madison, Wis., in 1855, and was educated in the public schools at Buffalo. At an early age he entered the machine shop of the Shepherd Iron Works of that city. He saw great opportunities in iron construction, then only slightly developed, and with this in mind became connected with the Kellogg Bridge Co. of Buffalo, as assistant engineer. After a number of years there he removed to Pittsburg as engineer of the Iron City Bridge Co. Five years later he became chief engineer of Riter & Conley, of Pittsburg, a concern then doing a moderate business in the construction of blast furnaces, steel works, etc. In the 15 years of Mr. Seaver's connection with this company the business developed to one of the greatest in the world. In 1896, Mr. Seaver, with S. T. and C. H. Wellman, organized the Wellman-Seaver Engineering Co. He occupies a prominent place among structural engineers and is a member of a number of engineering societies.

T. R. MORGAN, secretary and works manager of the Wellman-Seaver Engineering Co., is a native of South Wales. He came to this country in 1865 at the age of six. At Pittsburg his father organized the Pittsburg Steam Hammer Works and in 1868 the boy of 9 began work in the shop. For two years he fired the 75-h. p. boiler and in turn operated the engine and the various shop tools. He had reached the Pittsburg high school when his father removed to Alliance. The firm there was Marchand & Morgan, later Morgan, Williams & Co., and finally the Morgan Engineering Co. After finishing his studies at Mt. Union College T. R. Morgan entered the works at Alliance and served an apprenticeship in the various departments and spent some time in the engineering and drafting offices. At 16 he was superintendent of the works, at 21 general manager, and at 25 was secretary and general manager of the Morgan Engineering Co., holding this position until 1897. Then on the death of his father he disposed of his interests and severed his connection with the company, for the next four months enjoying the first vacation of his life. On taking up work again he formed his present connection.

The R. D. Nuttall Co.'s Plant at Pittsburg.

The R. D. Nuttall Co., of Pittsburg, is engaged in the manufacture of gearing, spiral, spur and bevel gears, racks and worm gearing coming under this designation, so far as their line of machine shop dentistry is concerned. The plant occupies some 75,000 square feet, one portion of the structure being six stories high. The heavy gear cutting departments are in a lofty single story extension supplied with an abundance of light. Pattern, tool making and small gear cutting have their respective departments in the taller building, together with the manufacture and assembling of trolleys for street railway work and mine locomotives, this company being the only concern having the right to manufacture such parts. This is a very important detail, though somewhat incidental to the car truck gears, which the Nuttall Co. turns out in such large quantities.

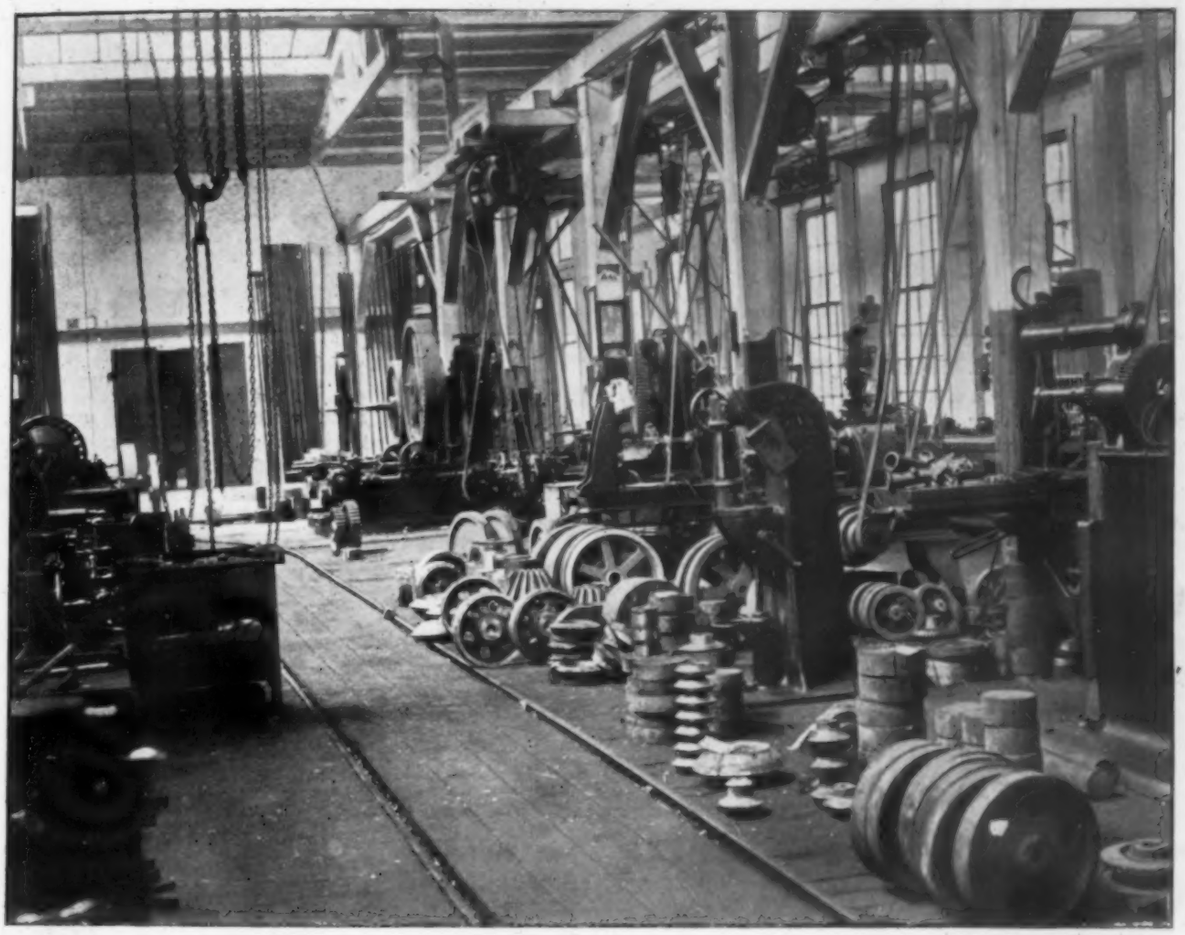


Fig. 1.—A Gear Cutting Department.

The main floor is divided electrically into seven sections; each driven by its own motor, and the convenience of this arrangement is a valuable factor when working overtime, or in case of a breakdown or any cause which is likely to tie up some part of the plant. The independent sections are then capable of continuing their work without delay on account of the one that may be temporarily put out of commission.

The power plant consists of three 125-h. p. gas engines of the Westinghouse type and direct-connected electric generators. A 75-h. p. steam engine is held in reserve against the possibility of accident to the gas engines. The latter are run with natural gas and work very smoothly.

There are about 200 men employed, and owing to the extreme pressure of business two shifts, day and night, are busily engaged. The men are supplied with lockers for the care of clothing, etc., and washrooms are arranged after the plan commonly found in modern machine shops.

It is not an easy task to state the limitations of a plant of this character with any degree of accuracy. The continual acquisition of new tools and ambition to meet all probable demands mean a constant enlargement of the field and an increase of the factory scope. I find that the firm is prepared to handle cut gears up to the following dimensions: Spur gears to 30 feet in diameter and 5 feet face; bevel gears to 8 ft diameter and 24-inch face; spiral gears to 50 inches in diameter, and worm gears are hobbed up to a diameter of 72 inches.

It is as well to say right here that the company makes cut gears only. The word "only" has a wider significance in this particular case than it usually receives; as may readily be inferred from the extent of the capacity as indicated by the above dimensions. The firm supplies patterns and material and does all the work on them; either boring, turning, keyway and gear cutting, as may be required, or the teeth will be cut from the finished material furnished by the customer. Any variation is permissible from the one operation to the complete series essential to the workmanlike production of a cut gear.

Fig. 1 illustrates a portion of the gear cutting department. This is equipped with the machine tools needed for the cutting of the small pitch gears, 48 p and coarser numbers. Some large gears are cut on the machines shown in the background of this view and the blanks on the floor suggest the varied character of the work. The track seen in the center of the half-tone is laid throughout the various floors and is a useful adjunct to the convenient handling of material, either finished or in the rough. There is no backward step taken, in the mistaken direction that there is any real economy in the use of poor arbors or the abuse of good ones, and the equipment generally is well supplied with arbor presses as shown in Fig. 1.

Fig. 2 is in a view of one of the rack cutting machines specially designed for the company. These have shoes and the necessary clamps for the ready attachment of all widths and lengths of rack stock within their capacity. There is no

suggestion of any possible need of a hunt through the mysterious depths of a scrap pile for the packing blocks, screws and straps to hold down the different widths of stock. There is no lack of variety here in the work and provision has been made for the wide range of sizes according to the needs and vagaries of the individual designers of gearing. The same conditions apply to the hobbing machine illustrated in the

from the one source, all being piped off the one pump and are drained in a similar way.

The spur gears for motor service are in halves and of different patterns. In one type the rim is of rolled steel in a U, or rather a channel, shape with square corners. These come in straight lengths and are pressed up hot in semi-circular form by a bulldozer in a special press. The two arms

Fig. 2.—Rack Cutting Machine.

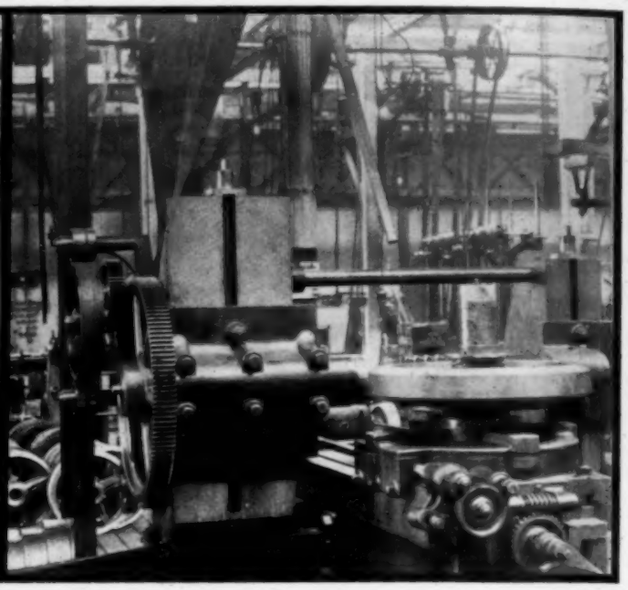


Fig. 3.—Hobbing Machine.

companion picture Fig. 3. Both are thoroughly automatic and positively driven machines.

Fig. 4 looks quiet enough in the picture, but in reality this is one of the busiest sections of the plant. Spur gears and pinions for street railway service are here turned out with a speed that is one of the most surprising features of the es-

are of cast steel and these are drilled in place by means of a jig and then riveted through with stout pins. There are some special machines on this floor for the cutting of spur gears, but there is a preponderance of the regular type of gear cutting machinery, as may be noted in the engraving. Many of the tools are equipped with a variable speed coun-

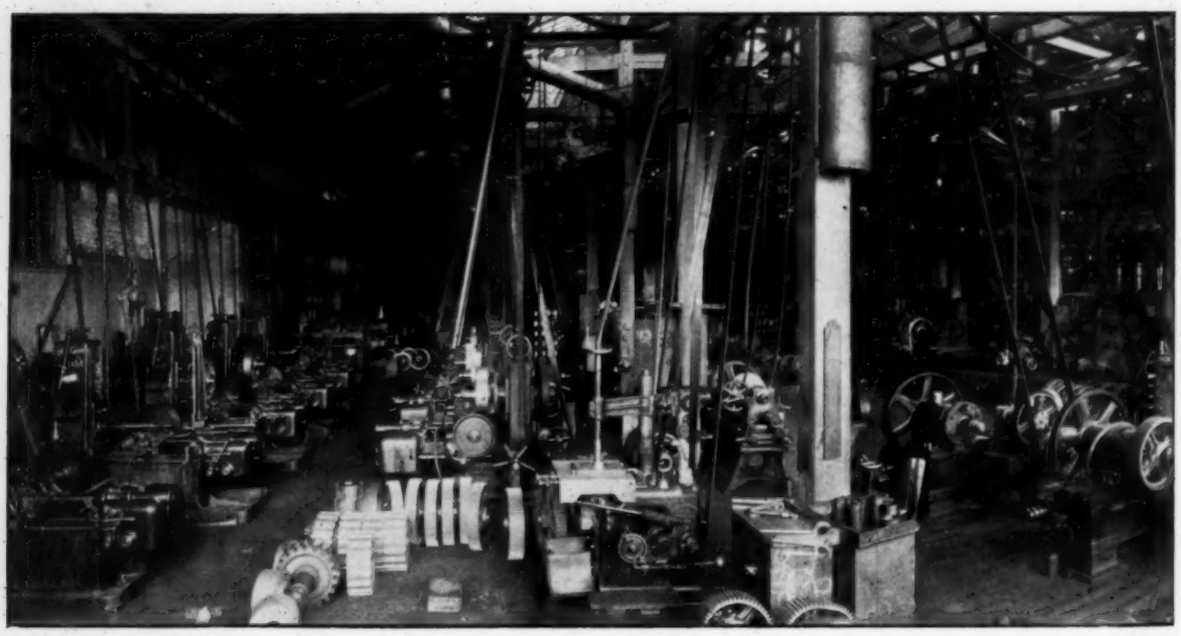


Fig. 4.—Motor Gear Department.

tablishment. The pinions are made of wrought steel and the spur gears are of cast steel. The blanks are bored and faced on heavy turret machines, a roughing cut is taken over the surface, and the rim on top and sides is then finished to size with a single cut in the special milling machines on the right of Fig. 4. These are powerfully geared and take a heavy cut in the tough metal. The machines in this department are all supplied with the lubricant for the cutting tools

tershaft and there is a general recognition of the benefit to be derived from this method of adjustment.

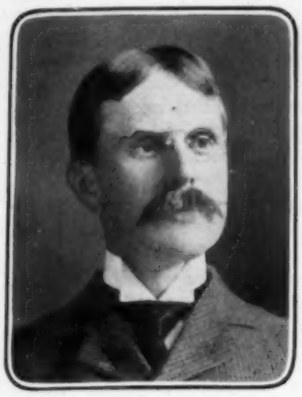
There are other interesting features of the R. D. Nuttall plant which will be taken up for consideration in a later issue.

The Webster, Camp & Lane Machine Co., Akron, O., has established an office in Cleveland, room 523 Garfield Bldg., in charge of Geo. H. Hulett, designer of the Hulett unloading machines.

Twenty-Five Years Progress in the Use of Alloys and Metals in Steel Manufacture.

By ALBERT LADD COLBY, South Bethlehem, Pa.

In interpreting the title assigned to him for this article, the writer finds it impossible, within the space alloted, to review properly under each of the elements, nickel, manganese, chromium, tungsten, molybdenum, etc., the interesting experiments made by steel metallurgists marking the quarter century of progress leading up to the present valuable applications of "special steels." A general review of the difficulties which have been overcome by investigators in the manufacture and treatment of "special steels" will therefore be given and this will be followed by a brief reference to the many important uses to which each special steel is now applied. Analyses of the steels and the ferro-alloys used in their manufacture will be given.



Albert Ladd Colby.

The foremost metallurgists, chemists and physicists of all countries have contributed to our present knowledge of special steels. The voluminous records of their researches and their deductions therefrom are most interesting; but these published records are by no means a measure of the labor and money devoted by the leading steel companies of the world in bringing to their present perfection such valuable applications of the "special steels" as the Krupp armor of Germany, the Holtzer projectile of France, the Hadfield manganese steel of England, the Taylor-White tool steel, and the nickel steel hollow engine shafting and nickel steel ordnance of the United States.

Furthermore, when it is recalled that the present commercial success of all the applications of special steel depends upon the existence today of cheaper and purer ferro-alloys of each of the rare metals used than were dreamed of 20 years ago, likewise obtained only by careful research, the impossibility of presenting a brief historical review of 25 years' progress in the development of each of the special steels will be apparent.

In general, however, it may be stated that each of the special steels originated and reached its present perfection from a demand for material of widely different or higher physical qualities than it was possible to obtain by the heat treatment of simple carbon steel, the mechanical properties of which can at best be varied between only narrow limits.

At first the rare elements were added to iron in only very small proportions, and in most cases the properties of the resulting alloys differed but little from simple carbon steels. In some instances in the earlier attempts to increase these percentages, the ingots could be neither forged nor rolled, although they had been apparently carefully heated. After painstaking work on the part of the steel works chemist, who had to first develop practical analytical methods for the accurate determination of each rare element, it was found that the special element added was very irregularly distributed throughout the ingot. When the steelmaker overcame this fatal irregularity in composition, the ingots containing the larger percentages of the element added could still be neither forged nor rolled successfully, and many experiments were necessary to develop the proper heat treatment, which, in some cases, proved to be entirely different from that ever used with simple carbon steel.

Similarly, when the special steels were tried for castings, they were in some cases impossible to machine, and many expensive experiments were necessary, even after uniformity in composition was attained, before the finished special steel casting of today was obtained with its valuable combination of physical properties.

With the removal of at least the main obstacles to the successful manufacture of cast, forged or rolled products of certain special steels, and the knowledge gained of the particular property given to steel by the addition of a certain element, the steel metallurgist next sought advantageous combinations of these properties by making steels containing two or even three of these rarer elements. These efforts have been attended with marked success, especially since the introduction of the richer and purer ferro-alloys and the pure metallic powders of the elements used.

Of late years the technical staff of the most prominent steel works, aided by independent investigators of international reputation, have devoted much time to special steels. Their micro-structure has been studied; their critical points accurately determined and with such data at hand heat treatments have been developed which have brought out some most remarkable and valuable combinations of physical properties. A study of their magnetic properties, their conductivity for electricity and for heat, their ability to resist corrosion, etc., has also led to their application for a wide variety of purposes. The incompleteness of this brief notice of the vast amount of research expended in bringing special steels to the position they occupy, will be most keenly appreciated by those who have been actively engaged in their study and who, perhaps, have aided in overcoming some of the many obstacles referred to.

Nickle Steel.

In point of tonnage, as well as in the importance and variety of the purposes to which it has been successfully applied, nickel steel with or without other special ingredients, such as chromium, tungsten, and molybdenum, occupies the first place among special steels. Nickel steels, from 1 up to 50 per cent of nickel, possess remarkable properties, varying with the content of nickel, but all of practical application. These properties have been thoroughly studied and it is mainly due to the price of nickel (never less than 35 cents per pound) that nickel steel has not been even more generally introduced. The cost of reducing nickel to the metal or to the form of oxide is excessive. If a nickeliferous pig iron analogous to ferro-manganese can be made at a less cost per

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ALBERT LADD COLBY graduated from the School of Mines of Columbia University, in chemistry and metallurgy in 1881. After pursuing post-graduate studies he was appointed in 1883 instructor in analytical chemistry and chemical philosophy at the Lehigh University, South Bethlehem, Pa. In 1886 he resigned this instructorship to accept the position of chief chemist to the Bethlehem Steel Co. of South Bethlehem, Pa. While engaged as such he originated many rapid and accurate methods, including the designing of special forms of apparatus for the analysis of iron and steel. In 1893 he was made metallurgical engineer to the company, a position which he still holds. Last year he was appointed one of the United States jurors to the Paris Exposition, and was also selected by the Association of American Steel Manufacturers as their official representative at that exposition. He was one of the official delegates of the United States to the International Congress on Methods of Testing Materials of Construction, and one of the delegates of the American Chemical Society to the Fourth Congress on Applied Chemistry, held in Paris in September, 1900. Mr. Colby's occasional contributions to the proceedings and discussions of American and foreign technical societies, and the pages of the technical press have established his reputation as an authority in the metallurgy of iron and steel. He is a member of the Iron and Steel Institute., the American Society of Mechanical Engineers, the American Institute of Mining Engineers, the American Chemical Society, the Society of Chemical Industry, the American Foundrymen's Association and the International Association for Testing Materials. He has recently been appointed a member of the visiting committee of the National Bureau of Standards, just established at Washington.

unit of nickel, the introduction of nickel steel for a still greater variety of uses is certain to follow.

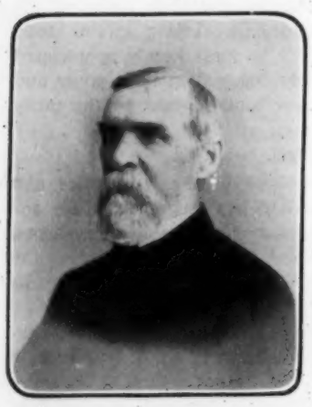
The successful manufacture of homogeneous nickel steel demands careful furnace practice. It is, however, in the forging or rolling and especially in the final heat treatment that greater care must be used than when manipulating simple steel of the same carbon content. A number of locomotive and engine builders making their own forgings from 3¼ per cent nickel steel blooms, and failing through careless treatment to secure the advantages possible, have condemned nickel steel as not worth its increased cost. This obstacle to its more general introduction is being rapidly overcome.

1. *Steels Below 10 Per Cent in Nickel.*—A steel containing 3 to 3½ per cent nickel is now regularly used by the United States navy for the principal solid and hollow shafting and engine forgings for battleships, cruisers and torpedo boats. Builders of merchant marine vessels have also used it for solid and hollow shafting and engine forgings in cases where high physical qualities were required. It is being largely used for hollow shafts for large pumping engines in municipal and mining plants, and in street and elevated railway power plants. All parts of a large pumping engine, even to the bolts and nuts, have been made of nickel steel. It is also regularly used in the manufacture of locomotive axles, crank pins, cross heads, piston rods, connecting rods, and pedestal bolts. Three and one-fourth per cent nickel steel has also been successfully introduced for rivets, piston rods for steam hammers and rock drills, and many other uses where in service the movable part is subjected to high alternating stresses.

Nickel steel castings have so far been more generally introduced abroad than in this country. Their future is, however, assured, as the higher elastic limit, combined with greater toughness and increased elongation, obtained by alloying nickel with steel are as valuable properties in a steel casting as in a steel forging. A Holtzer steel casting containing 2 per cent of nickel exhibited at Paris in 1900 showed a tensile strength of 97,712 pounds per square inch, an elastic limit of 65,568 pounds, and an extension in 3.9 inches of 18 per cent. Schneider & Co. exhibited a cast steel roll (4.4 per cent nickel) highly polished and with great hardness of surface. Holtzer also exhibited a 10 per cent nickel steel cast shaft for the motor of an automobile with the following remarkable properties: Tensile strength, 110,656 pounds; elastic limit, 84,201 pounds; extension in 3.9 inches, 12 per cent. At an American steel works a cast cylinder for a forging press, made of a piece of 6 per cent nickel steel, has been in successful operation for four years. Its finished weight is 90 tons and it withstands an internal pressure of three gross tons per square inch.

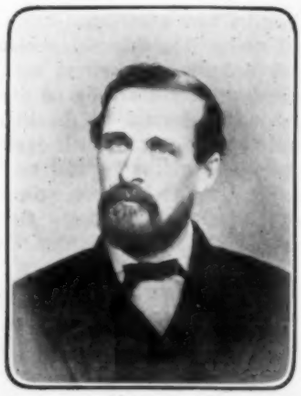
An 80 carbon steel with 3 to 5 per cent of nickel makes an admirable tool steel; its tensile strength is about 260,000 pounds per square inch.

Five per cent steel has been extensively adopted for gun barrels for "small arms" in which smokeless powder is used. Three and one-fourth per cent nickel steel is being used experimentally by the United States army and navy in the manufacture of ordnance, and is quite largely used for ordnance abroad. The physical properties of 3 to 3½ per cent nickel steel forgings have been so frequently quoted that repetition is unnecessary.



John Fritz.

Don H. Bacon.



George Fritz.

THE NAMES of John Fritz and his younger brother, the late George Fritz, are commonly linked together in reminiscences of the first important developments in American rolling mill and steel works practice. John Fritz, as one of the few survivors of that early period in our steel-making history, has enriched our records of progress by various papers dealing with the engineering advance of more than 50 years. Nothing could better testify to the respect in which he is held and the value put upon his work than the testimonial of prominent engineers of the United States, marking his 70th birthday. It took the form of a dinner at Bethlehem, Pa., on Sept. 28, 1892, when some 300 of his friends gathered from all parts of the country to do him honor. John Fritz was born in Londonderry township, Chester county, Pa., in 1822. At 16 he entered a machine shop at Parkesburg, Pa. In 1846 he went to the Norristown Iron Works at Norristown, Pa., of which he was in charge for several years. In 1850 he went to Safe Harbor, Pa., as a mechanical engineer, and in 1854 again removed to Johnstown, Pa., where as chief engineer and general superintendent he rebuilt the great Cambria Iron Works, remaining in charge six years. During this period, in connection with his brother George, he designed and erected their well-known three-high blooming mill with their automatic tables and their three-high rolling mill, besides working out the development of the feed tables. In 1860 he was called to take charge of the erection of the Bethlehem Iron Co.'s works at South Bethlehem, Pa., and from that time to 1893 he had direct charge as chief engineer and general superintendent of the great plant, which, with its complete equipment, owes its development and excellence very largely to his labors. He has been since 1893 consulting engineer of the company. His last work was the erection of the magnificent armor plate and gun plant, including the 125-ton steam hammer, the largest now in existence. Mr. Fritz is a member of many technical societies and has been honored by all of them. He has been president of the American Institute of Mining Engineers. In 1893 the British Iron and Steel Institute voted him the Bessemer medal. In 1895 when he received this medal at the hands of his warm friend, E. Windsor Richards, who had been commissioned to present it to him, he said with characteristic modesty: "I receive it not for what I have done, but for what American engineers and workmen by my help have accomplished." The story of Mr. Fritz's victorious fight for the introduction of three-high rolls at the Cambria Iron Co.'s plant, in opposition to practically the entire directory, is one of the most interesting of the reminiscences he has presented before our engineering societies from time to time.

GEORGE FRITZ was born in Chester county, Pa., Dec. 15, 1828, and died Aug. 5, 1873. He and his brother were brought up on a farm, the little early education they had being received in a log school house. He first learned the carpenter's trade; but in 1854 embarked in a machine shop enterprise with his brother—the Union Machine Works at Catasauqua, Pa. When John Fritz became superintendent of the Cambria Iron Works at Johnstown, Pa., Geo. Fritz was made head of the drafting department. In 1860 on the removal of the former to Bethlehem Geo. Fritz was made superintendent of the Cambria Iron Works. He had co-operated with his brother in bringing out the three-high mill. Under Geo. Fritz's administration some of the first steel rails produced in the United States were rolled, the ingots being made at the Penn-

Nickel steel was adopted by the United States navy for armor after its superiority over simple carbon steel plates, and a compound armor of steel and wrought iron, was so strikingly shown at the well known tests made at Annapolis in 1890. Today nickel steel or nickel-chromium steel is used either in part or exclusively for the armor-plate and protective deck-plate of the modern war vessels of all nations. Both these alloys give a greater resistance to penetration without at the same time increasing the danger of cracking.

2. 12-13 *Per Cent Nickel Steels.*—Judging from exhibits at Paris this steel, with or without chromium, seems to have a future. The following properties are claimed for a gun tube exhibited by Holtzer: Tensile strength, 194,429 pounds per square inch; elastic limit, 189,167 pounds; elongation in 3.9 inches, 15 per cent. For a hollow artillery axle containing 12 per cent nickel, exhibited by the Montbard works, a tensile strength of 248,504 pounds is claimed.

3. 20-25 *Per Cent Nickel Steels.*—A number of the French steel works are today making a 20-25 per cent nickel steel, either in the crucible or open-hearth, which they roll into thin plates used by the French artillery for a variety of purposes, such as cartridge boxes, etc. The following results are the averages of individual tests quoted by many exhibitors:

	Plates less than .08" thick	Plates .08" thick and over
Tensile strength, lbs. per sq. inch	92,450	96,005
Elastic limit, lbs. per sq. inch	46,936	51,203
Elongation, per cent in 3.9 inches	35%	38%

A 25 per cent nickel steel is also made into seamless boiler tubes. The softening produced by tempering renders the action of the fire much less dangerous than with simple steel tubes, and the polished surface lessens the corrosive action of the water. It is drawn into wire for making cables and springs, and to some extent for torpedo nets. Holtzer exhibited at Paris a breech block and the Montbard Works a gun tube made of 25 per cent nickel steel.

4. *Nickel Steel With Over 25 Per Cent ..ickel.*—Thirty-six per cent nickel steel has a less coefficient of expansion than platinum-iridium, and is only a little more readily oxidized than pure nickel. These properties make it applicable for instruments of precision, pendulum rods, etc., and as its electrical resistance is high, it is of advantage for rheostats. This latter property has brought this wire into practical use for electrical heaters for trolley cars, etc. Three American brands are sold containing 25 per cent, 28 per cent and 34 per cent nickel and one German brand with 29 per cent nickel. The nickel alloy does not become brittle after repeated heating and cooling, as is the case with German silver, which it is rapidly replacing.

Manganese Steel.

Mr. R. A. Hadfield's important papers published in 1888 called general attention to the unique properties of his manganese steel. His discovery, due to his boldness and perseverance in experimenting, has given us a special steel which, especially of late years, has been found eminently suitable for a wide variety of purposes, notwithstanding its extreme hardness, which was at first considered such a serious drawback to its usefulness.

While small proportions of manganese have but comparatively slight effect on the strength and ductility of steel, the effect of larger percentages is one of the most curious phenomena in steel metallurgy. From about 2 per cent up to nearly 6 per cent manganese, the steel is hard, but so brittle as to be practically worthless. A steel of 4 to 6.5 per cent manganese and .35 to .40 per cent carbon can be powdered with a hammer. Yet steel with 12 to 14 per cent manganese possesses an extraordinary combination of strength, hardness and toughness, especially after quenching in water. The material is also malleable, so that in both cast and forged shapes it has found many applications, among which may be mentioned:

The wearing parts of all kinds of machines used for crushing and grinding ores, rock, coal, coke, matte, slag, cement, etc.; screens and grates for sizing such material before and after crushing; sprocket wheels and chain used where there is excessive wear on account of dust; pins, bushings, bucket lips, teeth, etc., for dredges and steam shovels; wheels for mine and quarry cars; frogs, switches and crossings for street and steam railways; also window guards and door gratings for prisons, as well as burglar-proof safes and vaults.

Managanese steel is practically non-magnetic. The introduction of manganese steel wire for electrical purposes is at present more general abroad than in this country.

Chromium Steel.

As stated in the introduction, the history of the development of each special steel could not be given, owing to lack of space. This history is particularly interesting in the case of chromium steel, starting with the experiments in 1820 by Faraday and Stodart, and followed by those of Berthier, Frémy, Percy, Mushet, Parkes, Biermann, and especially of Julius Baur of New York in 1865, M. Brustlein of Unieux in 1875, and R. A. Hadfield of Sheffield in 1892. Since the general adoption of the Krupp patents by the largest armor plate makers of the world, chromium ranks next to nickel in the amount used in the manufacture of special steels. Chromium in itself has no great hardening influence on iron, but in the presence of carbon its influence is very marked. Though so intensely hard, chromium steel has a high resistance to shock, hence its special fitness for armor piercing projectiles, for which important purpose it was successfully introduced in France and England 20 years ago.

Chromium steel is adapted to severe service and resistance to abrasion, and has hence been quite generally introduced for machinery castings such as spinning dies and chucks, gears, pinions, worms, hammer dies, and the wearing parts of stamp mills, such as battery shoes and dies, cams, tappets and bosses; also roll shells, ring dies, rollers, crusher jaw plates, toggle bearings, etc. Chromium steel has also been used in England since 1892, and in Russia since 1896, for special railroad springs, and to some extent for locomotive tires. In the United States it has been introduced for safes. The safe plates consist of five plates welded together. The central and outside plates are of fibrous iron separated by two plates of chromium steel. Although doubtless proof against ordinary burglar tools, neither the manganese steel safe nor the chrome steel safe has ever been tested ballistically in comparison with the Harveyized armor plate safe, which latter has not only stood the severest tests with burglar tools, but is also proof against a possible attack with field guns due to mob violence, an emergency which must be thought of when absolute safety is the essential feature desired. The armor plate vault can also be built as large as desired.

Another application for chromium steel is for tools; 1.5 to

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sylvania Steel Works at Harrisburg. Soon after this the Cambria Iron Co. decided to put up a Bessemer plant. With A. L. Holley as consulting engineer Geo. Fritz carried on this work and the completed plant was the best of its day. His most important work was the improvement of the means for handling and shaping the ingot. The hammer and the three-high had been used. The hammer was too expensive and the mill was imperfect and unsatisfactory. He believed rolling to be the proper system, and by many changes—the introduction of driven rollers in the tables, means for turning and shifting the ingot and other minor improvements—he brought out the precursor of the modern blooming mill. Mr. Fritz showed mechanical and architectural engineering ability of the highest order, and had his life been spared would have ranked among the country's foremost engineers.

Don H. Bacon was born in 1850 in Bradford county, Pa., and in 1862 located in Michigan. When 19 he became a telegraph operator for the Cleveland Mining Co., now the Cleveland-Cliffs Iron Co., at Ishpeming. By successive steps as timekeeper, cashier and assistant superintendent, he reached the superintendency of the mine in 1880, and in 1883 was agent, or manager; continuing in this position until 1887, when he went to Minnesota. He conducted the explorations of the Chicago & Minnesota Ore Co. and his name will be associated most intimately with three of the great mines of the country, the Minnesota, Chandler and Fayal. Mr. Bacon early in 1901 left the mining field of the lake region to assume the chairmanship of the Tennessee Coal, Iron & Railway Co.

2.0 per cent of chromium with about 1.0 per cent carbon gives a tool of extraordinary hardness. Chromium is usually associated with tungsten in self hardening steels, in amounts varying from .25 to 3.50 per cent.

An instructive series of chromium steels were exhibited at Paris in 1900, by Holtzer and also by the Soc. Anon. de Denain and d'Anzin. The Holtzer series contained about .40 per cent carbon and the tests had been hardened and annealed. The other series are evidently higher in carbon:

Holtzer & Cie.				Soc. Anon. de Denain & d'Anzin.			
Per cent Chromium.	Tensile Strength	Elastic Limit.	Extension in 3.9 in.	Per cent Chromium	Tensile Strength	Elastic Limit.	Extension in 3.9 in.
5.0	123,600	109,200	12.0	1.60	136,500	130,800	10.5
10.0	121,600	95,000	12.0	2.16	151,700	135,700	7.5
15.0	130,100	109,200	11.5	3.47	163,900	151,600	11.0
20.0	91,100	61,700	19.5	4.00	176,300	170,700	9.5
25.0	90,600	61,700	21.0	6.67	146,200	109,900	8.0
30.0	87,300	64,500	19.0	10.10	127,300	108,100	12.0
35.0	(Tests unsatisfactory.			12.00	147,000	111,800	8.0

Tungsten Steel.

Tungsten imparts hardness to steel, but to a less degree than either chromium or molybdenum. Although malleable, tungsten steel should be forged at a low temperature; it hardens without quenching, so that tungsten steel tools are known as "self-hardening" or "air-hardening." It is also used for car and locomotive springs, the points of frog rails, for rolls, and the shoes of stamp mills. Magnets and wire for certain electrical purposes are made of tungsten steel as magnetic retentiveness is greatly increased by tungsten. Small percentages of tungsten increase the strength and ductility of wire of small calibre used for needles and piano wire.

Since the comparatively recent introduction on the market of pure metallic tungsten its consumption in the manufacture of special steels has greatly increased.

Taylor-White Tool Steel.

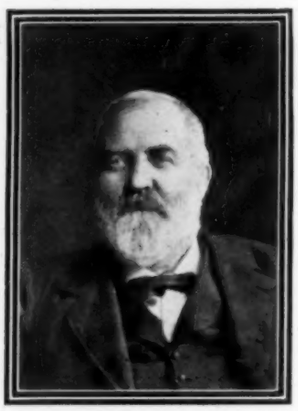
This remarkable invention consists not so much in the composition of the self-hardening steel which contains both tungsten and chromium, as it does in the novel heat treatment which gives the treated tool an efficiency ranging from one and one-half to two and one-half times that of air-hardening steel treated by the old method.

Molybdenum Steel.

Molybdenum is used for much the same purpose as tungsten. In general it takes about half as much molybdenum as tungsten to produce a given result. Molybdenum increases the elongation of steel and also its ability to withstand shock. These properties have recently been more generally appreciated, and molybdenum steels are coming into more general use for a wide variety of purposes, including tool steel, ordnance, forgings, projectiles, etc. It has been used experimentally in the manufacture of armor plate.

Molybdenum seems particularly advantageous in steel when combined with either nickel or nickel and chromium. Quite recently the demand in the steel industry has been so active for this metal, or its ferro-alloy, that makers have had diffi-

Charles McCreary.



Geo. W. McClure.

David Lamond.

CHARLES MCCRERY, second vice-president of the Tennessee Coal, Iron & Railroad Co., in charge of operations, was born Aug. 25, 1868, at Catoctin Furnaces, Frederick county, Md., where he received his early training under his grandfather, the late Col. J. Baker Kunkel, proprietor of the Catoctin Iron Works. After filling various minor positions he was made manager of the blast furnaces at 18, which position he filled until the autumn of 1887, when with a view to gaining more technical training he went to Troy and later obtained a position with the Troy Steel & Iron Co. as assistant superintendent of blast furnaces. In 1889 he was promoted to manager and resigned in 1894 to accept the management of the Dunbar Furnace Co. of Dunbar, Pa. He remained until January, 1898, when he accepted the management of the Duquesne Furnaces of the Carnegie Steel Co. His phenomenal records with the Duquesne Furnaces are well known. He was first to demonstrate by practical operation the possibilities and economy of giant blast furnaces. On Oct. 1, 1900, he resigned the management of this plant and for a short period was connected with the Dominion Iron & Steel Co. at Sydney, C. B., Canada, as general superintendent. On Aug. 1, 1901, he accepted the vice-presidency of the Tennessee Co.

GEORGE W. MCCLURE, founder of the firm of G. W. McClure, Son & Co., engineers and contractors, Pittsburg, is the oldest living blast furnace contractor in the United States. Born in Pittsburg, Sept. 13, 1836, he received his early education in the public schools of Pittsburg and at 22 became a contractor. His first work in the blast furnace line was with the firm of Lyons & Schaub, on the Allegheny Mountains, this firm at that time also operated the Sligo plant at Pittsburg. He built blast furnaces also for John H. Shoenberger and James Wood, they being among the pioneers in the iron business at that time. Mr. McClure was largely instrumental in bringing into use a number of improvements in blast furnace construction now generally used. He has also had extensive experience with the different methods of heating air for blast furnace practice, first with the old system of cast iron pipe hot blast stoves down to the present most satisfactory method of heating air through fire brick hot blast stoves. In his early days a capacity of 10 or 20 tons daily was considered enormous. Gradually the size of the furnaces was increased, however, until the big daily output of the modern furnace was achieved. In 1883 Mr. McClure formed a partnership with A. Schuler; the death of the latter caused the firm of McClure & Amsler to be formed in 1888. Upon the death of Mr. Amsler in 1894, James W. McClure, a son, was taken into partnership, and in 1899 J. B. Pearson became attached. The company makes a specialty of blast furnace and fire brick hot blast stove construction and has built a large number of blast furnaces and stoves all over the country. For a number of years it has been exceptionally busy building Massicks & Crooke's fire brick hot blast stoves, with McClure & Amsler's and G. W. McClure's patent improvements.

DAVID LAMOND, of Pittsburg, consulting and contracting engineer, is one of the oldest blast furnace builders in the United States. In his many years of experience in this work he has made many departures in blast furnace construction which have been distinctly marked. When quite a young man he came to this country from Scotland, where he received his training in blast furnace work, and entered the employ of the Cleveland Rolling Mill Co., Cleveland, O. Later he was placed in charge of the Sheive Works, at Knightsville, Ind., where he built two blast furnaces and a rolling mill. In

culty in finding a sufficient supply of molybdenum ores to meet their requirements.

Vanadium Steel.

In 1830 Sefstrom discovered vanadium in the pig iron made from Taberg (Swedish) Magnetites and in the wrought iron and refining slags made from the pig. In 1881 Witz and Osmond showed that the vanadium present in some high phosphorus pig irons was recovered with the phosphorus in the Thomas-Gilchrist basic-Bessemer process. They stated that the Creusot basic-Bessemer slags might yield 60,000 kilos (about 60 tons) of vanadium per annum. In 1893 J. E. Stead reported that vanadium accompanied chromium in pig iron; he found from .183 to .262 per cent in five samples, the highest in Cleveland pig iron.

M. K. Helouis was the first to call attention to vanadium steel. In June, 1896, he published the following results of his experimental addition of vanadium to wrought iron and steel:

	Tensile Strength, lbs. per sq. inch.	Elongation, % in 4 inches.
Wrought Iron, no Vanadium (not annealed)	55,470	19
" " 0.5% " " "	87,116	12
" " 0.5% " (annealed)	75,382*	32
Soft Steel, no Vanadium (not annealed)	67,200	17
" " 0.5% " " "	93,872	16
" " 1.0% " " "	137,964	14
" " 1% " (annealed)	101,984†	23

*This annealed bar showed great malleab lity and ductility.
†This annealed bar. though very soft, took a remarkably high temper.

In June, 1900, experiments on vanadium steel were reported by an English steel metallurgist, to the Alloys Syndicate, who have since distributed the "confidential report" so generally among those possibly interested, that it is no breach of confidence to state that the report shows that vanadium more than doubles the elasticity of steel, and nearly doubles its tensile strength; and further that in its effect on tool steel it resembles tungsten, but is from 10 to 20 times as powerful as the latter element.

Owing to the discovery of vanadium in Creusot slags, above referred to, it is easy to believe the report that Schneider & Co. have experimented with the addition of vanadium to armor plate and ordnance steel, but with what actual practical results the writer has been unable to ascertain. Makers of ferro-vanadium claim that the alloy has been purchased for experimental purposes by the principal steel works of England, Germany and France and by at least two or three works in the United States, and hint at its use for armor piercing projectiles, ordnance, armor and tool steel.

Vanadium steel will beyond doubt give, with proper heat treatment, high elastic limit combined with high ductility and contraction of area. Granting all that is claimed for vanadium in augmenting this desirable combination of the properties of steel for both high and low carbon content, it remains that vanadium steel will never be of more than academic interest until the price of ferro-vanadium is materially reduced. The lowest price on ferro-vanadium delivered in the United States quoted to the writer on recent inquiry from all domestic and foreign makers was $12.50 per pound of metallic vanadium; the highest price was $48.48 per pound. To add 1 per cent of vanadium to steel would therefore add to the price of a pound of steel from 12½ to 48 cents, or from $280 to $1,075 per gross ton. Until these figures are materially reduced the steel maker will be pardoned for not taking more than a passing interest in the metallurgical luxury!

Titanium Steel.

Mushet was so thoroughly convinced of the beneficial effect of titanium on steel that he took out some thirteen patents to protect his invention. Howe in his "Metallurgy of Steel" states "in an undoubted sample of Mushet's 'titanic steel' which I obtained personally from the maker's American agents, and which was stamped as such, neither Shimer nor H. L. Wells could detect titanium, though they have made its determination a special study." This statement is confirmed by the writer's personal experience. This is not surprising, as titanium is easily oxidized along with the other electropositive elements. In the writer's experience no trace of titanium was found in a heat of Bessemer steel made entirely from a ladle of direct pig metal containing .107 per cent of titanium.

Titanium steel has, however, been made. In 1889 the St. Chamond works exhibited at Paris a tool steel with 1.30 per cent carbon and .45 per cent titanium. Titanium is said to increase the strength of steel without any sacrifice of ductility. Recently it has been authoritatively stated to the writer that steel containing ".5 per cent titanium or less" is made into wire of small calibre for piano wire, needles and certain electrical purposes, and that titanium is added to steel with tungsten for certain special purposes. It is true, however, that the addition of titanium to steel has not reached much importance commercially, nor will it do so until a purer and less expensive ferro-alloy is offered.

Unlike some of the rarer elements used in making special steels, the supply of titanium is inexhaustible, that is, if the maker of high grade ferro-titanium or metallic titanium can use titaniferous iron ore as a raw material.

Silicon Steel.

Silicon is a well recognized important factor in iron and steel metallurgy, but its consumption for the manufacture of silicon steels, strictly speaking, is still limited. Holtzer exhibited some silicon steels in 1889. Hadfield reports that a steel of 2 per cent silicon and 1 per cent carbon hardens in the same way as chromium and tungsten steels and is also tougher. A steel containing 1.50 per cent silicon has of late years been used to some extent in France for special railway springs. The Soc. Anon. de Denain et d'Anzin exhibited at Paris in 1900 a series of silicon steels having the following properties:

Percent Silicon.	Tensile Strength.	Elastic Limit.	Extension in 3.9 inches.
2.48	123,100	87,200	14.5%
2.48	133,800	99,100	11.0%
2.48	273,000	24,300	6.00
2.48	271,600	.....	3.0% (Hardened
3.00	121,400	95,700	13.0%
3.00	134,500	113,800	6.0%
4.00	127,300	127,300	0.5%

Copper Steel.

In 1888 Henri Schneider of the Creusot Works, took out patents in France, England and the United States for a method of alloying cast iron and copper, the alloy to be subsequently used in making a 2 to 4 per cent copper steel, which it was claimed was particularly adapted to the manufacture of ordnance, armor projectiles, etc. At the Paris Exposition in 1889 Holtzer exhibited three samples of copper steel made for experiment. They contained 3 to 4 per cent of copper and showed in the hardened bars high elastic limit with fairly good extension. The writer knows of a recent instance where a steel containing 1 per cent copper was furnished for small gun barrels under rigid specifications.

It is improbable, however, that copper steel will ever be of commercial importance.

A tract of land comprising about 55 acres adjoining Monessen, Pa., where the Pittsburg Steel Co. is erecting its new plant, has been sold to officials of that company and others for $225,000. The property will be cut up into building lots

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Plans have been prepared by the Union Steel Co., Donora, Pa., for the erection of a new steel bridge over the Monongahela river. It will contain four tracks and will be used by the Union Steel Co. in order to secure the shipping facilities of the Pittsburg & Lake Erie railroad, in addition to those of the Pennsylvania railroad.

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the fall of 1873 he resigned to take charge of the construction of a new furnace at Ironton, O., which was considered one of the best plants in the country. At this plant were erected, simultaneously with those at Rising Fawn, Ga., the second fire brick stoves in this country. Early in 1876 he located in Pittsburg, becoming a member of the firm of Witherow, Shephard & Lamond, and erected the first fire brick stoves in Pennsylvania, at Dunbar, Fayette county. After this firm dissolved partnership he became connected with the firm of Witherow & Gordon as superintendent of construction. Later he embarked in business for himself. While doing much mill work his specialty is the designing and construction of blast furnaces. He is sole agent for the C. H. Foote patent fire brick stoves.

ALEXANDER E. BROWN.

Alexander E. Brown was born at Cleveland in 1852; received a public school education and later took a special course in civil and mechanical engineering at the Polytechnic of Brooklyn, N. Y., in 1872. He was a year with Dr. F. V. Hayden on the original U. S. Geological Survey to Yellowstone Park and afterwards became chief engineer of the Massillon Bridge Co., holding this position until 1874, when he established himself as mechanical and civil engineer in Cleveland. From 1878 to 1879 he was in the employ of the Brush Electric Co. as mechanical engineer and chief assistant to Charles F. Brush. In 1880 Mr. Brown took up the question of the handling of materials and the betterment of terminal facilities at the lake ports, more particularly in regard to iron ore and coal, and organized the Brown Hoisting & Conveying Machinery Co. in that year. At present Mr. Brown is vice-president and general manager of the firm which succeeded the parent company and has taken out hundreds of American and foreign patents. He is also secretary and treasurer of the Elwell-Parker Co., a member of the American Society of Mechanical Engineers, the American Society of Mining Engineers, the Cleveland Society of Civil Engineers, the Cleveland Society of Electrical Engineers and the Engineers' Club of New York.

Alexander E. Brown.

Obituary.

Arthur B. Meeker, of Chicago, died in Utica, N. Y., Nov. 6. He had been identified with the iron and coal trade of Chicago for nearly 30 years. Mr. Meeker was born in Utica in 1834 and in 1856 became a resident of Chicago. The iron ore mines of northern Michigan were then scarcely known and he was one of the first to grasp the possibilities of the territory, being interested in the opening of iron mines and the operation of charcoal blast furnaces. He was the founder of the first large steel plant at Joliet, the builder of two of the early blast furnaces in Chicago and the promoter of other steel enterprises. For many years he was the senior member in the iron commission firm of A. B. Meeker & Co., and also of Meeker, Hedstrom & Co., miners and shippers of coal, until his retirement in 1885.

John Graff, for many years an active figure in iron and steel circles in the Pittsburg district, passed away at his home, Pittsburg, Pa., on Monday, Nov. 11, at the age of 80 years. While still in his teens he went to Philadelphia, where he was employed in one of the transportation offices of the Union Canal Co. His father later turned his attention to the iron business, and with the coming of railroads the elder Graff abandoned his canal interests entirely and devoted his attention to the making of iron. In 1845 John Graff went to Pittsburg and for several years he was engaged as a salesman for the iron firm of Graff, Lindsay & Co. In 1852, together with James I. Bennett and Robert Marshall, both now deceased, he formed the firm of Graff, Bennett & Co. The iron mills of this firm, the Clinton rolling mill and the Clinton furnace company, were located on the South Side. The output of the firm's mills consisted almost entirely of rod and bar iron and nails. The firm occupied a conspicuous place in the iron industry, and continued in business until about 10 or 12 years ago.

No. 1 Garrett rod mill of the Illinois Steel Co. at Joliet, Ill., made a 24-hour record of 455 tons on Nov. 4. The No. 2 Garrett mill turned out 469 tons on Nov. 7. The two mills made 877 tons in 24 hours on Nov. 7. The two finishing mills are fed by one continuous roughing train.

A LEADER IN OPEN-HEARTH PRACTICE.

H. H. Campbell, general superintendent of the Pennsylvania Steel Works at Steelton, Pa., was born March 10, 1859. He graduated at the Massachusetts Institute of Technology with the degree of S. B. in the department of metallurgy and mining in 1879 and in the same year entered the employ of the Pennsylvania Steel Co., occupying a minor position in the Bessemer and open-hearth departments. In this work he was associated with C. E. Stafford in the production of the first basic Bessemer, or Thomas Bessemer, steel made in this country. This occurred in May, 1883. Mr. Campbell became superintendent of the open-hearth department in 1885, was promoted to the position of assistant superintendent of the works in 1893 and in 1897 became superintendent and general manager.

He became a member of the American Institute of Mining Engineers in 1881, the American Society of Civil Engineers in 1894, and the Iron and Steel Institute in 1897. His first paper of note was upon the physical and chemical equations of the open-hearth process, which appeared in the nineteenth volume of the transactions of the Mining Engineers. This able paper was so much appreciated that Mr. Campbell was requested by the Council of the Institute to write an account of the open-hearth process for the World's Congress at Chicago in 1893. He accordingly wrote a very voluminous paper upon that subject, which was incorporated in the transactions of that society.

In 1895 he published his standard work on "The Manufacture and Properties of Structural Steel." This has already passed through two rapidly exhausted editions and his friends and publishers have prevailed upon him to undertake a new edition which he has now in course of preparation. The third edition will appear in the early part of 1902 and will be 50 per cent larger in order to include a full and improved treatment of blast furnace and open-hearth subjects as well as a discussion of the iron industry in the United States, England, Germany, France, Austria, Sweden, Spain and Italy.

Mr. Campbell has a world-wide reputation as a foremost steel and iron metallurgist. His publications and his papers, reprinted in the proceedings of the leading technical societies of this country and abroad, are considered classics by competent authorities. Thanks to his indefatigable industry and technical skill many processes have been removed from a purely empirical foundation to a scientific basis. The tilting open-hearth furnace is his invention, and the value of this improvement is daily becoming more manifest. Steel making apparatus and practice, the heat and other treatment of steel, have been much modified and improved through Mr. Campbell's work as an investigator and a progressive teacher.

New Gifts of Mr. Carnegie to Pittsburg.

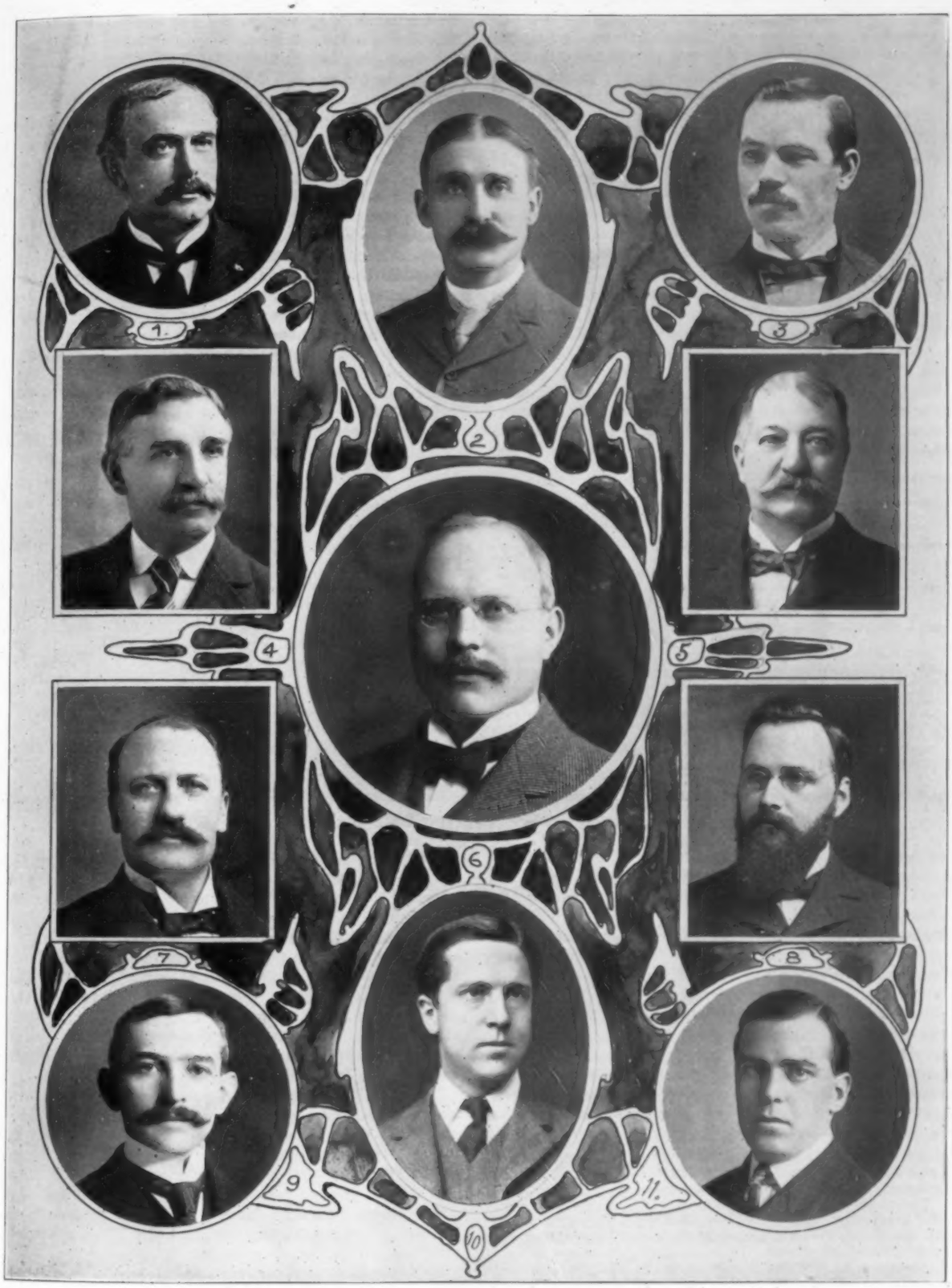
(Special Telegram.)

Pittsburg, Nov. 13.—Andrew Carnegie announced yesterday that he would increase the endowment of the Carnegie Institute from $1,000,000 to $2,000,000, and that of the Polytechnic School likewise from $1,000,000 to $2,000,000. His gifts to Pittsburg to date amount to more than $14,000,000.

The Youngstown Mfg. Co. will place its new nut and bolt works at Struthers, O., in operation about the first of the year. It has been practically decided to erect an addition to the plant for the rolling of iron to be used in the manufacture of nuts and bolts.

The Fischer Foundry & Machine Co. of Pittsburg, Pa., has been incorporated with a capital of $200,000. The directors are G. L., G. L. Jr., H. B., Fred F. and Albert Fischer. Fred F. Fischer has been elected president; H. B. Fischer, secretary, and G. L. Fischer Jr., treasurer. The firm has heretofore existed as a limited partnership and the plant is located on the South Side. Extensive improvements are in contemplation in addition to the big improvements made thus far this year.

ENGINEERS OF THE CARNEGIE STEEL CO.



1. A. R. Hunt, General Superintendent of Duquesne Steel Works and Duquesne Furnaces. 2. E. F. Wood, Assistant Superintendent Homestead Steel Works. 3. Thos. Morrison, General Superintendent Edgar Thomson Steel Works. 4. James Scott, Superintendent Lucy Furnaces. 5. L. T. Brown, General Superintendent Upper and Lower Union Mills. 6. W. E. Corey, President. 7. P. T. Berg, Mechanical Engineer Homestead Steel Works. 8. Geo. K. Hamfeldt, Superintendent Carrie Furnaces. 9. Alva C. Dinkey, General Superintendent Homestead Steel Works. 10. Ambrose Monell, Engineer of Tests, Homestead Steel Works. 11. John C. Neale, Structural Engineer.

The Development of Rolled Structural Shapes.

BY F. H. KINDL.

While cast iron and forged iron were made and used by the ancients it is not until the employment of the puddling furnace by Henry Cort in 1784 that we can trace the rolling of iron in its plastic condition. Henry Cort's patent of 1784 reads: "By a process of puddling exposed to the current of flame and air the cast metal could be rendered malleable." He soon found out that by subjecting the plastic puddled iron to a rolling process by means of grooved rolls the separation of the slag was more quickly and thoroughly accomplished than by the use of the hammer.

F. H. Kindl.

While the art of rolling various sections found in the market today took many years of labor and study for its completion, it can be safely said that the above event marks the origin of the rolling process. At first simple forms of bar iron were rolled for blacksmith purposes. They were subsequently welded and forged into various articles, mostly for chains, and thus used in suspension bridges. Gradually the rolling of plates was accomplished, so that in the place of the cast iron steam boiler as then known, the riveted plate iron boiler was destined to come into use. The process of rolling wire also became known and cables took the place of chains in the construction of suspension bridges.

The first application of rolled material was probably in connection with the shipbuilding industry. Here it was found that the wooden hulls, which were strong enough for sailing purposes, could no longer stand the stresses to which their frames were being subjected due to the introduction of heavy steam engines for their propulsion. The clumsy wooden joints of the ribs, planks, deckbeams and knee-bracing were gradually replaced by iron bars and gusset plates properly bolted to the wooden members and found to be a much superior construction. In 1820 Aaron Manby of Birmingham constructed the first iron plate girder which was used for the deck construction of a vessel. In the same year John Berkinshaw of Bedlington rolled the first practical rail; but it should be noted that Nixon rolled a rail section in 1805, which owing to its flat shape was found impractical. The rail shape no doubt was the forerunner of all difficult rolled shapes. However, the ordinary angle and tee irons being used for the construction of boilers, girders, etc., were rolled at a prior date. During this lively period of inventive progress the transmission of vehicles by means of steam (the forerunner of our present automobile) made rapid strides and the absolute necessity for a substantial roadbed with rails for safe and fast travel became just as apparent to those great inventors as it does to the chauffeur of today, when he attempts to run his automobile at a reasonable speed over the average American country road. Thus the adoption of a substantial roadbed with rails fastened to the ties was brought about, causing a great demand for rails and their accessories, such as chairs, splices, etc. The rail shapes were redesigned, made more economical in section and the method of rolling was much improved.

Cast iron rails which had been commonly used were abandoned, and in 1831 the broad based rail of Stevens, light in weight, but approaching the present American Society Civil Engineers' Standard Section was introduced. As the weights of locomotives increased the rail section was made proportionately heavier; and it may be of interest to note that the standard locomotive of 1840 was made about three times as heavy as that of 1830, (no precedent for automobiles), and had about ten times more capacity while the weight of the train increased about twenty fold.

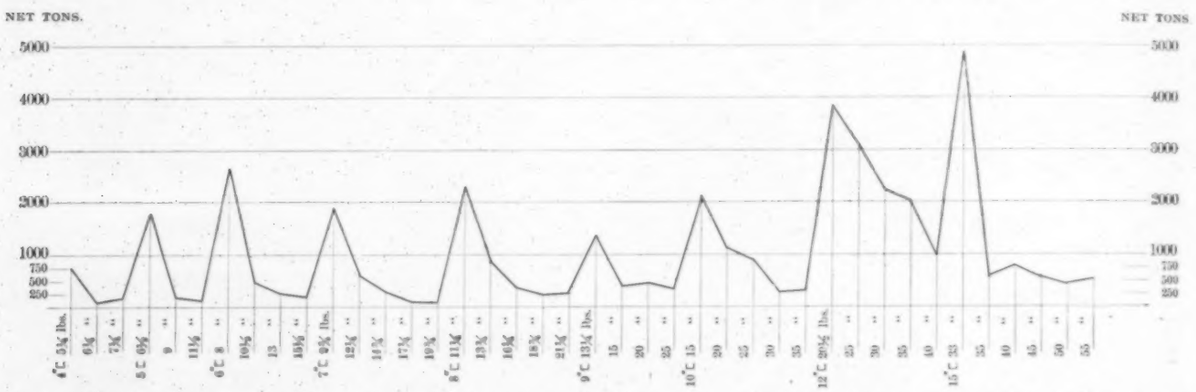


Fig. 1.—Chart showing relative production in net tons for one year of each size and weight of Channel Beams, at one of the largest structural mills in the country.

The English who at first had the entire field of experiment for themselves guarded their method of puddling and rolling in grooved and finishing rolls so well that it was not until the year 1818 that the first puddling plant was introduced at Creusot, France. The United States was really first to place itself independent of England. After 1840 but few locomotives were imported by the United States.

In 1820, after the method of rolling plates became better known, the use of plate girders for bridges and shipbuilding was given more attention, but not until 1840, through the introduction of the box girder by Brunel and Fairbairn did we find wrought iron bridges replacing those of cast iron and wood. Here it is no more than proper that we dwell a few moments on the subject of bridge construction, as to this art we owe more than to any other for the development and introduction of our present structural shapes.

In 1840 William Howe patented his well-known Howe truss, using rolled rods for tension members. The earliest type of iron truss construction in the United States was the invention of Wendell Bollman, it being really a suspension system and used largely on the Baltimore & Ohio railroad during 1840-50. In 1851 Albert Fink brought out the Fink truss, still largely favored for roofs and deck bridge construction. In both the Bollman and Fink designs the compression mem-

FRED H. KINDL, whose contributions to the technical press of this country and of Europe are well known to mechanical engineers, is a product of the Case School of Applied Science of Cleveland, from which he received the degree of C. E. After graduating from the Cleveland High school he engaged with the Brush Electric Co. as a machinist, later taking his course at the Case school. After graduating he was employed as an engineer by Vierling, McDowell & Co., Chicago. In 1889 he was employed as a structural engineer by Carnegie, Phipps & Co., of Pittsburg. He was later made chief structural engineer of the Carnegie Steel Co., Ltd., and in 1900 became one of the partners of this concern. On July 1, 1901, he resigned his position with the company and is now engaged on various large undertakings as consulting engineer. As a structural engineer, Mr. Kindl holds a high place and his contribution to the development of the structural shapes in use today has been conspicuous.

bers were made of cast iron. The first approach to the modern style of iron truss bridges was made by Squire Whipple in 1852, and to him belongs the credit of having first analyzed the stresses in his bridges, also correctly dimensioning the rolled shapes and other members used in their construction. It was he who also introduced pin connections in the bottom chords of bridges, thus founding the design of the present recognized American type of railroad bridge.

It was not until 1863, however, that wrought iron was used in compression members, it being introduced by J. W. Murphy; and even then cast iron was still applied in all joint-blocks and pedestals. Not until 1870 was cast iron abandoned in all railroad bridge construction and since about 1880 in all highway bridges as well. In England the first wrought iron lattice bridge was constructed in 1845 for the Dublin Drogheda railroad, and this construction soon spread over the continent where such eminent engineers as Cullman, Schwodler, Winkler and others developed the well known principles of our present stress calculations for bridges and roofs.

With the different designs of compression members came the request for suitable structural shapes. It is fair to credit England with having first rolled angles, tees and zees, and France with designing and rolling the first I beams and

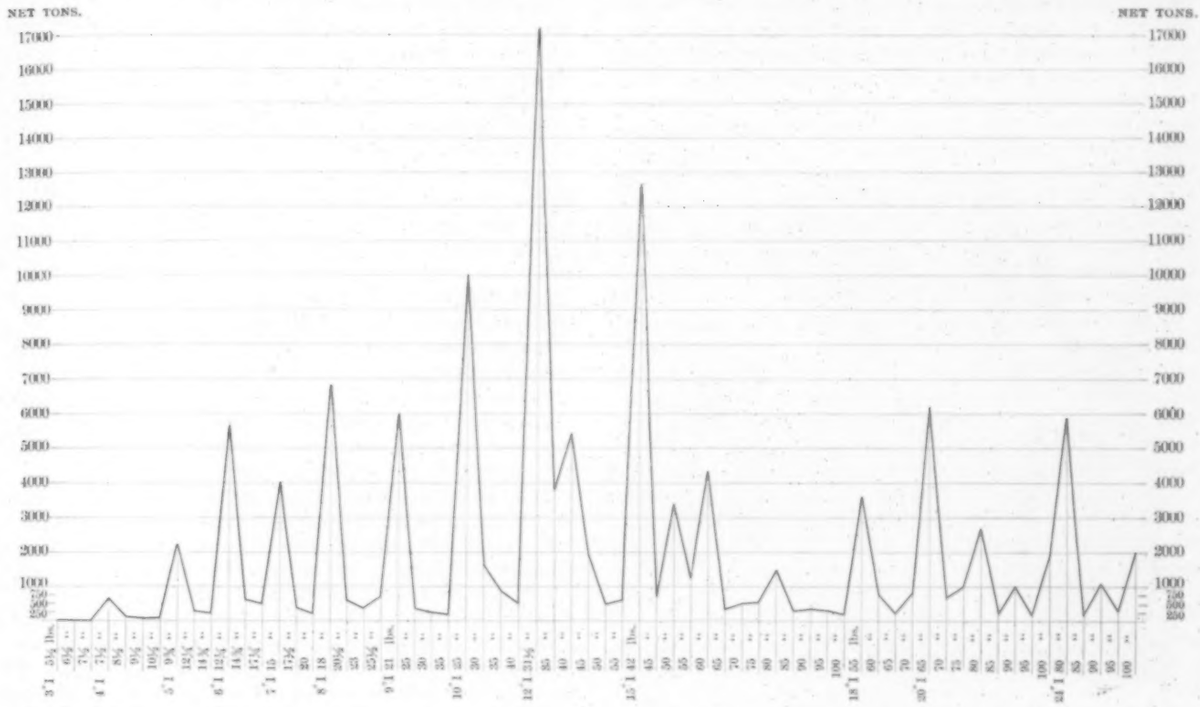


Fig. 2.—Chart showing production in net tons for one year of each size and weight of I Beams, at one of the largest structural mills in the country.

channel sections, while the United States can claim the origin of the first segmental shapes so much found in the older designs of built columns. The use of wrought iron shapes for compression members caused an increased demand for structural shapes for bridges, and consequently a more general distribution of their use for other constructions such as vessels, cars and buildings, until today, with the exception that the material is no longer wrought iron, but steel, they form the very skeleton of all modern structures. While the tendency to use rolled structural shapes in place of cast iron was being recognized by all prominent engineers, still cast iron presented so many advantages to the architect, such as home production, quick deliveries, less cost per pound, easy variation of design to suit architectural features, etc., that the strife between these two materials so closely allied was extremely interesting. This may not have been so interesting to the rolling mills; in fact I know it was not, as it cost them a fortune to educate the public to the use of rolled shapes, and rolling mills are not run on the charity hospital plan nor for the education of the public.

This great struggle for supremacy between cast iron and rolled wrought iron applied particularly to columns for building construction, where every inch of ground had to be contested; and not until within the last ten years, and mostly due to the untiring efforts of the structural engineers engaged by the mills and largely assisted by the introduction of steel in place of wrought iron, was the battle for the rolled steel built column won for all time to come.

While bridge construction is largely responsible for the use of rolled shapes, the designers and engineers of structures are responsible for the various shapes that from time to time have been rolled, the practical mill man (roll turner) for the general dimensions of the section and minimum and maximum sizes, to which such shapes can be rolled, and the rolling mill management, particularly the engineering department, generally a branch of the sales department, for reducing the number of shapes and the adoption of the present standards. From the foregoing it must be admitted that a combination consisting of engineers, practical mill men and business managers, working hand in hand, is quite necessary for the development of any structural shape.

This necessity was hard for the mills to comprehend at first. It was also difficult to establish such a complete organization; but it was gradually accomplished, and while not recognized today as a special department by the management, yet the introduction of any new shapes follows through this same channel before being passed upon. That is, an engineer, architect or manufacturer sends a new design of section to the mills with an inquiry as to the cost of rolling the same. Being new business it goes to the sales department, which refers it to the engineering department. Here a general examination is made, proper drawings prepared, and the properties, such as sectional area, weight per foot, moments of inertia, etc., are figured. This information goes to the superintendent of the rolling mill with request for cost of rolls, cost of rolling and his general view as to the desirability of rolling such a section as well as the minimum tonnage which should accompany the first order.

The answer from the mill, after being recorded by the engineering department is referred to the sales department for final disposition. While this general routine of introducing a new section was quite the same in all mills, yet owing to the great competition between the managements of the various companies, no understanding existed between them tending to minimize the number of sections or to make them uniform in design, so that the product of one mill might replace that of another. In fact not so long ago when rolled sections

were sold by the middle man to the consumers by the foot, the requests made to the mills to reduce the weight per foot were of the most ridiculous character. When not meeting with success at one mill others were tried with more or less success. Thus it was that each mill rolled its own shapes to a greater or less extent and had its own accessories and standards.

James Christie.

This same condition of affairs existed in England and on the continent, only a great deal aggravated, owing to the greater number of competitors and the more radical differences of opinion by engineers who it must be admitted as a rule are a good deal more individual in their plans and specifications than is considered good practice in the United States.

It remained for the German societies of architects and engineers to call attention to this embarrassing situation (of having to figure with different properties for shapes having the same depth and general dimensions depending upon the mill at which they were rolled) and to suggest a remedy, namely, to standardize all their rolled shapes to what are known today throughout the civilized world, using the metric system, as the German Norman Profiles. That the method pursued by the Germans, in establishing their standards was most thorough is confirmed by the fact that upon the committee selected for this purpose can be found the names of most eminent professors of engineering, architects, mechanical engineers and directors of rolling mills, bridge works and shipbuilding plants, as well as government officials of the highest standing.

In the year 1879 the exact dimensions of these shapes were determined upon and in 1881 the first edition of what is known as the German Normal Profile Book of rolled shapes for structural and shipbuilding purposes made its appearance. The designs of these rolled shapes were quickly recognized as superior to all previous sections and in view of being properly tabulated, carefully figured as regards area, weight per foot and other properties, they were adopted as standards, not only by the Germans, but most foreign countries in which the metric system was in vogue, and are still being used.

These Normal Profiles are without doubt the first sections designed in which both theory and practice were given due consideration in all directions. Not only were they designed to meet the demands of the practical detailer of structural work, but also had regard to economic production at the mills.

I dare say, had we had the metric system in the United States 20 years ago (as we should have had and I regret to say we do not yet have), we would probably be using Normal Profiles today. We would not have such a vast selection as the Germans, as I consider this a mistake from the mill standpoint of economy, but we certainly would have saved our engineers many nights of sleepless toil in going over the same grounds as our German friends and saved the American rolling mills many thousands of dollars which were spent in experimenting and changing rolls until our present system was finally adopted.

The principles upon which this system of Normal Profiles was designed are in reality the foundation of our present standards, with but few exceptions, and it may be interesting to quote them.

Charles C. Schneider.

First. All lithographs and tables of rolled shapes pertain to finishing passes, as it is not to the interest of the producer or the consumer to use roughing passes or to raise the rolls on finishing passes.

Second. In fixing the design of the Normal Profiles, their dimensions are to be such as to produce satisfactory details for shop work, as well as to suit rolling mill practice, keeping in mind such disposition of the metal as to give maximum strength.

Third. In adopting a comprehensive nomenclature for the sections such as to allow for any future insertion or addition, without interfering with the system. It was decided that the main dimension of the section shall fix its number. Thus a 400 millimeter I beam is numbered 40; a 240 millimeter channel is numbered 24; a 160x160 millimeter angle is numbered 16; a 100x150 millimeter angle 10/15, etc.

Fourth. For the determination of the sectional areas of Normal Profiles, their weights, centers of gravity, position of main axes and their corresponding moments of inertia and section moduli; the exact shape was considered inclusive of fillets.

Fifth. All weights of rolled shapes to be based upon assuming one cubic meter to weigh 7,800 kilograms corresponding to 486.94 pounds per cubic foot for iron and 7,850 kilograms corresponding to 490 pounds per cubic foot for steel.

Sixth. In the tables for calculation of strength and deflection due to transverse loads a maximum fiber stress of 1,200 kilograms per square centimeter has been used corresponding to practically 17,000 pounds per square inch.

The following exceptions to the above rules were made in figuring the Carnegie standard structural rolled shapes:

No. 1. The raising of rolls between finishing passes of beams and channels, I believe is to the detriment of the consumer more than to the mills, as in all raised passes the additional weight of the section is placed entirely in the webs in place of being distributed into the flanges where it is most effective for transverse loads. Therefore consumers to get the most for their money should endeavor to use finishing passes, and if possible the minimum weight of each section, as these generally are more economical for their weight per foot than the heavier finishing passes of the same size or depth. To show that this fact is pretty well known to consumers I attach a tonnage diagram showing the relative production of different weights of beams and channels for one year at one of

JAMES CHRISTIE, chief of the mechanical engineering department of the American Bridge Co., was born near Ottawa, Can., Aug. 28, 1840, of Scotch parents. He received his primary education in the schools of his native town and at an early age entered a locomotive plant at Detroit, Mich., as a machinist's helper. He finished his apprenticeship as a machinist with the firm of I. P. Morris & Co., of Philadelphia. In 1872 he became interested in the construction and designing of bridges and engaged in that business at Phillipsburg, N. J., until 1876. He next accepted the position of mechanical engineer with the Pencoyd Iron Works, Pencoyd, Pa., and served as chief of the department until the formation of the American Bridge Co., when he was appointed to the position which he now holds. Mr. Christie is a member of the American Society of Mechanical Engineers, the American Society of Civil Engineers, a fellow of the American Association for the Advancement of Science, member of the Engineers' Club of Philadelphia, the Franklin Institute and Grand Army of the Republic. He was awarded the Norman medal by the American Society of Civil Engineers in 1884.

ANOTHER GRADUATE of the Pencoyd Iron Works of Philadelphia, Pa., whose ability and achievements were properly appreciated upon the formation of the American Bridge Co. is Charles Conrad Schneider, vice-president of the company with charge of the engineering department. He was born in Apolda, Duchy of Saxe-Weimar, Germany, April 24, 1843, and received his education in the schools of his native city and in the Royal School of Technology, at Chemnitz, Germany. After leaving school he served an apprenticeship in a machine shop to gain a practical knowledge of the working of iron and later began the study of civil and mechanical engineering. In 1868 he came to the United States and for three years was employed as a draughtsman in the Rogers Locomotive Works, Paterson, N. J. Leaving this plant he accepted the position of assistant engineer of the Michigan Bridge & Construction Co., at Detroit, Mich. In 1873 he was placed in charge of the engineering department of the Erie railroad with offices in New York City, which position he held for two years. The following two years he was engaged as designer for the Delaware Bridge Co., and from 1877 to 1886 he practiced his profession as consulting engineer at New York. In 1886 he accepted the position of chief engineer of bridge construction of the Pencoyd Iron Works, Philadelphia, which position he held until the formation of the American Bridge Co.

the structural mills, from which we can predict that in the near future none but minimum sections or standard I beams or channels will be called for, excepting channels used for the top chords of bridges in connection with a top plate.

No. 2 holds good with the Carnegie designs of rolled sections.

No. 3. It was found impractical to use the nomenclature as in the Normal Profile system, and not until after the year 1890 did we have a satisfactory system. With the introduction of steel beams a new nomenclature was devised by Mr. C. L. Strobel and the writer, which has for its basis the designation of the shape by its first letter as B for I beams, C for channels, A for angles, etc., and affixing a number to each of these sections then existing. This has become the standard nomenclature and has given practical satisfaction.

No. 4. In determining the properties of rolled shapes the fillets were not considered in the calculations, as the work involved in figuring the properties with their exact fillets was exceedingly tiresome and the percentage of error in omitting them so small as not to make an essential difference.

No. 5. All weights for shapes rolled of iron were based on 480 pounds per cubic foot, while those for steel are based on 489.6 pounds per cubic foot.

No. 6. In the table for calculation of strength and deflections for transverse loads a maximum fiber stress of 12,000 pounds per square inch was allowed for iron and 16,000 pounds per square inch for steel. While this has particular reference to the Carnegie structural shapes it will be admitted the Carnegie Steel Co., formerly Carnegie Bros. & Co., and Carnegie, Phipps & Co., are directly responsible for the present adopted standards. The Carnegie shapes were designed by Charles L. Strobel, based upon the above fundamental principles and subsequently modified by Mr. Charles M. Schwab and the writer to suit modern rolling mill practice. As the new steel I and channel sections were about 25 per cent lighter than those of equal carrying capacity rolled in iron they were quickly recognized by both engineers and architects and so widely specified that all the structural mills prepared to roll them, thus following in the wake of that great leader of the American steel industry, who set the pace in the rolling of shapes as well as in most other branches of the manufacture of iron and steel.

The shapes adopted by other mills were close designs of the Carnegie steel sections but differed slightly in some minor details, such as the slope of flanges, diameter of fillets, minimum weights, etc., and it was not until the so-called gentlemen's agreements (the forerunner of the present great United States Steel Corporation) became better established that uniform dimensions and weights were adopted by all mills of the beam pool. This was accomplished through a committee composed of representatives of each mill who after several meetings accepted the present standard I and channel sections.

Through a similar evolution we could trace the progress of designs for rails up to the present American Society of Civil Engineers' section, known throughout the world as the American standard. In this connection I note that the A. S. C. E. are considering slight changes in the standard rail section by increasing the thickness of the flange, and I take the liberty to suggest that this seems a wise move as the present flange thickness at their extreme edge is too thin to admit of positive rolling, causing unnecessary tonnage of seconds.

A simple and practical method of accomplishing a satisfactory change would be to reduce the width of flanges instead of increasing their thickness and add the loss of weight to the head of the rail, thus bringing the center of gravity almost at the center of the rail which would tend to increase slightly the transverse carrying capacity. The ratio between the flange width and height is now as 1 to 1 for American standards. I am quite sure it would be satisfactory to the mills and still give sufficient width of base for good railroad practice if this ratio were made $\frac{b}{h} = 9\text{-}10\text{ths}$, noting that this ratio was adopted by the International Railroad Congress held in Paris in 1889 and produces a rail giving entire satisfaction. The advantages of the standardization of rolled structural shapes, in fact, standardization of manufactured products in general, are not only recognized by the manufacturers but must sooner or later be apparent to consumers, as the good results that have followed from it have brought us the profound admiration of the industrial world.

Note.—For historic data Merten's "Eisen" and Johnson, Bryan & Turneaure's "Treatise on Bridge Construction" have been referred to.

MAYWOOD GAS AND GASOLINE ENGINES.

The demand for engines in plants in which all power is electrically distributed by means of motors, direct connected to machine tools, fans, blowers, pumps, ice machines, grinding machines, elevators, air compressors, wood working and other machinery requiring steady power, and for furnishing current for both arc and incandescent lights, all on the same circuit, with rapidly fluctuating load, ranging from the maximum capacity to almost no load, requires engines which will preserve perfect economy in the consumption of fuel, and at the same time maintain a steady and uniform speed throughout the entire range of their capacity. To meet the call for such a power producer to take the place of the steam engine, with its coal and ashes, its boilers and leaking steam pipes, its water service, its pumps and condensers, and its more expensive attendance and maintenance, the Maywood gas and gasoline engine has been designed. It is a vertical multiple cylinder engine, with the crank shaft, cam shaft, rocker shaft, connecting rods and all main bearings and working parts enclosed in an oil-tight base running in an oil bath, lubricating all parts, including cylinders and pistons.

The possibility of hot bearings is thus done away with and the parts being enclosed are free from dust and require no care except to be kept tight and to add oil occasionally to the crank case. The cranks, cams and rocker shafts, igniter cams and rods are all accessible by removing the front doors. The main bearings and connecting rods are reached through the

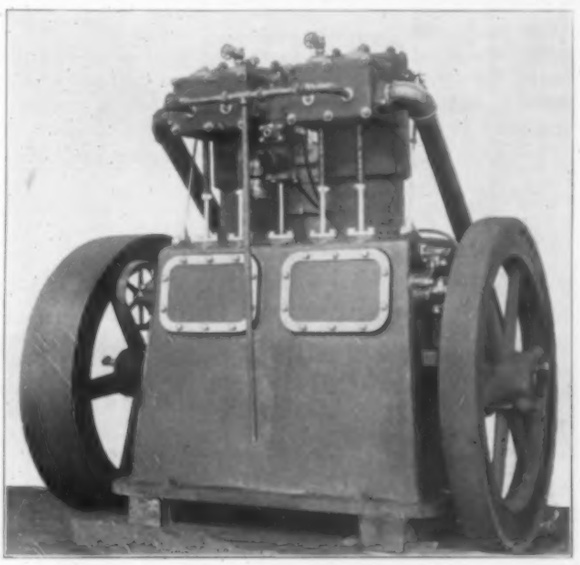


Fig. 1.—Maywood Gas Engine, 50 H. P.

rear doors. The connecting rods and crank shafts are forgings, heavy and substantial. The main crank bearings are of babbitt and the crank and wrist pin bearings of phosphor bronze. The pistons are heavy and have five spring rings. The tops of the pistons are removable for adjustment of the wrist pin bearings without taking out the pistons. The cylinders are heavy, with water jackets of large size. The valve chests, which are water-jacketed, are bolted on the front of the cylinders and are so made that when valve seats are worn they can be bored out and bushed.

The valves are of the direct-acting poppet type. The igniters are operated by hardened steel cams on the cam shaft. They are removable. Current for ignition is obtained from an Edison-Lalande battery and spark coil, or direct from dynamo. It is usual to connect them up with both battery and dynamo by means of a double throw switch, using the battery to start with and then switching to the dynamo as soon as in operation. This saves the battery and furnishes a ready means of knowing whether the igniters are working properly by the breaking of the circuit on the three or four incandescent lamps through which the circuit passes.

In planning for governing their engine the manufacturers have departed from the "hit and miss' principle by which with a full charge a powerful explosion runs the speed of the engine up above the normal, and there follows a slowing down

until the governor causes it to take another heavy charge. The heavy explosions cause great strains and in a single cylinder engine thus operated the variation in speed is very great. The Maywood being a multiple cylinder engine and operated with a throttling governor, takes a charge every revolution on the double cylinder, and a charge every two-thirds of a revolution on the three cylinder engine. The amount of fuel admitted to the cylinders and the force of the impulse admitted to the cylinders. The mechanism responds promptly to wide fluctuations of load in plants operating arc and incandescent lights, elevators, blowers, air compressors, wood working machinery, machine tools, etc. The proportion of gas or gasoline to air is regulated by a valve and may be instantly changed to give from one portion of gas to eight of air or one portion of gas to twenty of air, as the quality of the gas being used may require. A dial over which a

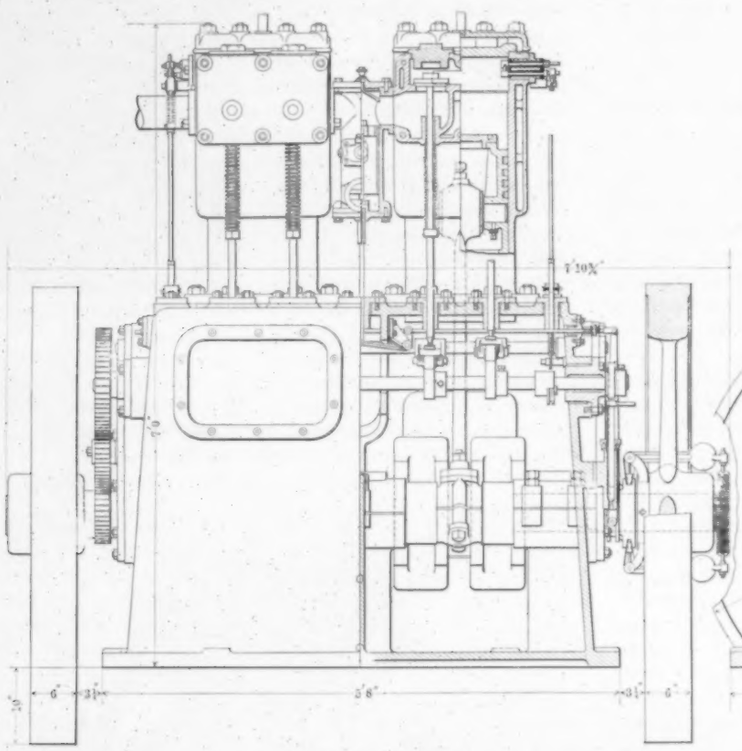


FIG. 2.—FRONT ELEVATION.

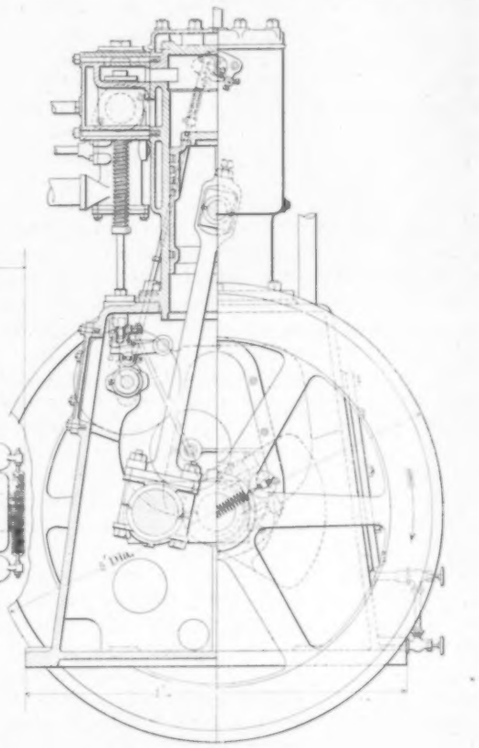


FIG. 3.—SIDE ELEVATION.

12½ x 16-inch 50 H. P. Maywood Gas Engine.

Fig. 4.—Three 50 H. P. Maywood Gas Engines in Maywood Foundry and Machine Co.'s Plant.

are proportioned to the requirements of the load. This gives uniformity of speed and power. The governor is of the flywheel type and acts directly by means of a lever and rod on the mixing chamber valve, through which both the air and gas are admitted in proper proportions to form a perfect explosive mixture. The motion of the lever and rod opens or closes this mixing valve as the load may require, and thus the exact amount of explosive mixture necessary to carry the load is pointer attached to the lever operating the gas valve moves, indicates the exact proportion.

The Maywood engines are so built that either gas or gasoline may be used, and if desired are furnished with both gas and gasoline inlet, so that a change can be instantly made from one to the other while the engine is running, by shutting off one valve and opening the other.

The manufacturers are the Maywood Foundry and Machine Co. of Maywood, Ill.

A Summary of Development in Open-Hearth Steel.

BY AMBROSE MONELL.

The manufacture of open-hearth steel at the present day can justly be said to represent the keystone of the steel industry; yet the history of its development, aside from the experimental stage, covers less than 35 years. In 1845 Josiah Marshall Heath, the eminent metallurgist, was granted a patent, the specification of which described the method of melting together malleable iron and pig metal in an open-hearth furnace for the production of steel castings. But while the production of steel on an open hearth was discussed and experimented with for a number of years, nevertheless the process was not a success until the introduction of the Siemens regenerative furnace and its attendant high temperatures.

Dr. Charles William Siemens introduced into Europe the Siemens regenerative gas furnace, on which a patent was granted Frederick Siemens in 1856 (British patent No. 2861) covering the regenerative principle both as applied to solid and gaseous fuel. In 1857 a patent was taken out by Dr. C. W. Siemens covering the application of regenerators to puddling furnaces (British patent No. 1320) and later in 1861 a patent was granted Dr. C. W. and Frederick Siemens for the application of regenerators to furnaces with a gas producer for iron, glass, pottery, etc. (British patent No. 167.)

Early Operations in Europe and the United States.

From 1861 to 1868, the open-hearth advanced but slowly and Dr. Siemens in his attempts to introduce his process met with many practical difficulties. During these years it was experimented with at various places in England, among which Tow Law (1862) and Barrow (1863) were the earliest. Furnaces were also run for a short time in 1867 by both Messrs. Rowan & Co., Glasgow, and the Bolton Steel Co.

In France, in conjunction with Messrs. Emil and Pierre Martin of the Sireuil Works, who obtained a patent in 1865, Dr. Siemens produced open-hearth steel of good quality as early as 1864, the steel produced being put into gun barrels. Subsequent to this time the process was known as the Siemens-Martin in England and the Martin-Siemens on the Continent. In the following year Dr. Siemens started to erect steel works of his own at Birmingham, Eng., for the production of open-hearth steel, the first furnace being of one ton capacity. In this plant open-hearth steel rails were made in 1868 for the Great Western Railway, and in the same year open-hearth steel manufacture was first taken up on a commercial scale, one of the chief reasons for this being the success obtained with the process by Mr. Ramsbottom at the Crewe Works of the London & Northwestern Railway Co. The formation of the Landore-Siemens Steel Co. in 1868, together with the satisfactory results obtained at the Crewe Works, brought the process to the attention of steel manufacturers most forcibly and it was soon installed, on what was then a large scale, by the Steel Company of Scotland, the Dowlais Iron Co, the Panteg Steel Co., Messrs. Vickers Sons & Co., Ltd., and others, until at the end of 1880 there were 126 furnaces erected and 17 in the course of erection.

The first open-hearth furnace in America was built by Cooper, Hewitt & Co., owners of the New Jersey Steel & Iron Co.'s works at Trenton, N. J., in 1868 under the supervision of F. J. Slade, but the experiment was not very successful. Two years later S. T. Wellman designed and built an open-hearth furnace at the Bay State Iron Co.'s plant in Boston, Mass., which produced steel on a commercial scale. This furnace poured through a forehearth directly into the molds; and it might be of interest to add that Mr. Wellman has recently employed the same idea in the construction of 50-ton furnaces for the works of the Tennessee Coal, Iron & Railroad Co. at Ensley, Ala.

Features of the First Furnaces.

The earliest Siemens furnaces were rectangular with vertical regenerators situated directly under the hearth. The roof of the furnace was low and the air and the gas mixed at the top of the up-take, no port construction such as exists at present being then in use. The charges were extremely small, from three to six tons being the average charge in England and France, while in Sweden the first furnaces built were at Kilefors and Hellefors and charged only 450 to 500 lbs. During the early 70's in England it was considered good work to produce 50 tons of ingots per week with the best furnaces then in use, but as this small output per furnace necessarily meant a high cost for fuel and labor, the furnaces were gradually increased in size, until ten years later furnaces of 12 to 15 tons capacity were in general service. This line of development has been followed until today 30 and 40-ton furnaces are the rule and 50-ton furnaces are not uncommon.

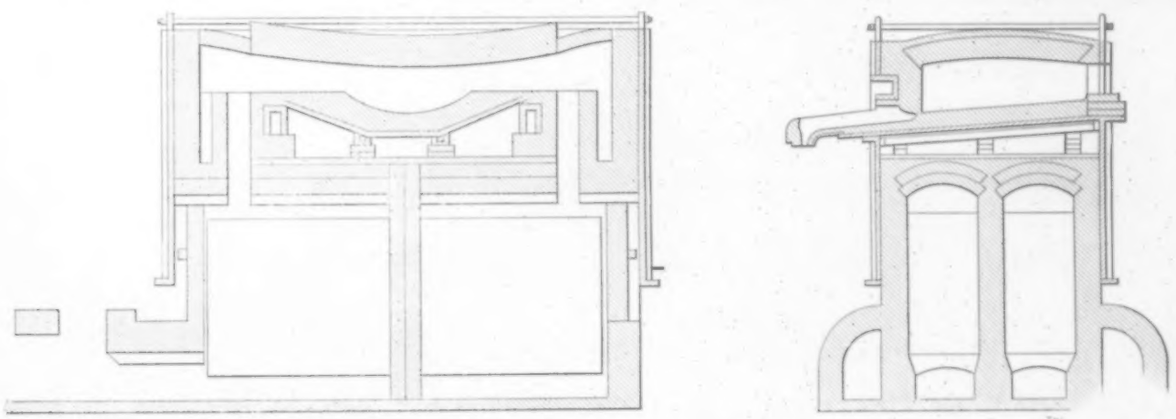


Fig. 1.—Early Open-Hearth Furnace. Capacity 3 Tons.

The earliest furnaces were built on the ground level with regenerators under the ground and more or less inaccessible, the furnace proper being bound together with cast iron plates and braced with a system of girders. Dr. Siemens at first experienced considerable difficulty in obtaining suitable brick for the roof and side walls of the furnace, as the ordinary Dinas brick which was at the time considered the most refractory melted rapidly at the high temperature obtained. But a brick made of perfectly pure silica with about 2 per cent of lime as a binder was found to be satisfactory and has been in use from then to the present time, although improvements in the brick making processes have so greatly lengthened the life of this refractory that while in the early

days from 50 to 100 heats were made on a roof, it is not at present uncommon to make from 400 to 500 heats.

Earlier Modifications.

Numerous changes were made in the construction of the early furnaces as the study and practice of the process

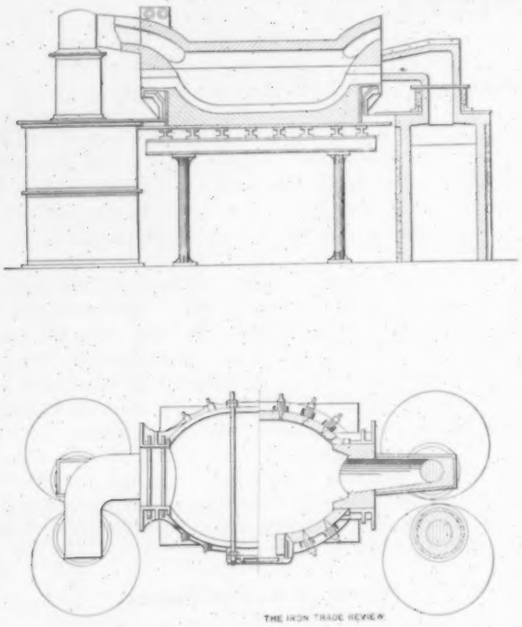


Fig. 2.—Batho Type Furnace. Capacity 10 Tons.

brought out the defects then existing, such as too low roofs, combustion of the gas and air at the wrong point in the furnace, flame development, too small regenerators (which generally led to too close piling of the checker work), gas and air port side by side, shape of hearth and depth of bath. The flues, ports and stack were also too small for proper draft and the weight of the roof was taken by the side walls.

For some time more attention was paid to the shape and dimensions of the furnace proper and the size of air and gas ports, but later the size of the regenerators was given more study. The arrangement of ports in which the air is introduced above the gas was described in a patent taken out by Charles William Siemens in 1871 (British patent No. 3077) and a modification of this port was later patented and generally known as the "Hackney" port.

An important change was the raising of the furnace roof by Frederick Siemens in order to allow free flame development and heating by radiation. This idea was correct, but for a time the error was made of proceeding to an extreme and keeping the flame off the surface of the bath, whereas in order to obtain the best results the flame should play along the surface of the metal. Another marked improvement was the separation by Hackney and Wailes of the entrance flues from the furnace proper. Changes in the line of reduction in the depth of the bath, relative to the size of the heat and the lengthening of the furnace, resulted in greater heating surface being exposed, better efficiency from the gas and protection at the port ends; all of which were distinct advantages, as was clearly indicated by the reduced coal consumption. A forced blast has been occasionally adopted, but was not generally thought to be good practice, a powerful stack being much more satisfactory.

From 1873, when the Pernot furnace was first introduced at the works of Petin and Gaudet, various more or less modified forms of the Siemens regenerative furnace were built, among which possibly the best known was the Batho type, including the furnaces of Riley, Dick, Wailes and Hilton. From 1878 to 1890 the rectangular furnace and vertical regenerator design was very largely abandoned. Many round and oval furnaces made their appearance, together with the horizontal regenerator of H. W. Lash. Both of these departures were grave mistakes. The round furnace of Riley was not adapted to the proper distribution of the flame, as it was impossible, owing to the shape of the furnace, properly to fill its sides without burning out the port ends, and in the case of the horizontal regenerator no equalizing of the temperature of the checker work occurs as in that of the vertical regenerator, since the hot products of combustion tend to travel through the upper portion of the checker work and the cold incoming air through the lower portion. There was only one small advantage in the horizontal type of regenerator, namely, a little less excavation in cases where furnaces are built on the ground level, or a charging floor a little more accessible when the furnaces are elevated. Before 1895 these forms of furnaces and regenerators were recognized as faulty and the rectangular furnaces with vertical regenerators were universally readopted; the regenerators, however, being moved out under the charging floor and a slag pocket introduced at the bottom of the down-take.

The Batho type of furnace has had numerous advocates, principally in Great Britain. Briefly described, it consists in a combustion chamber and independent regenerators, the two parts being connected by tubes, but otherwise entirely

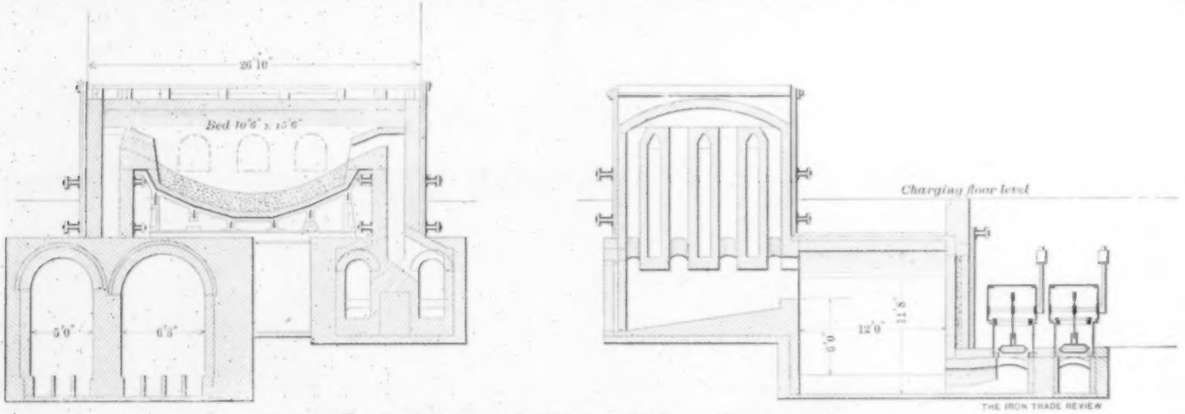


Fig. 3.—Otis Steel Co. Furnace, 15 Tons Capacity, 1887.

separate. The regenerators carry nothing but their own weight and are provided with a full length door to facilitate cleaning checkers. The cylindrical regenerators of Riley and Dick, encased in iron shells, were added with the idea of reducing to a minimum the difficulties of expansion and contraction, but owing to the difficulty of keeping up the necks at the top of the regenerators and the cost of frame work this furnace was not generally adopted.

Pernot and Ponsard Furnaces.

The Pernot furnace was first introduced in 1873 at the works of Petin and Gaudet in France as a mechanical puddling furnace and was designed to hold 2,200 pounds. A little later Mr. Petin produced steel in this furnace by introducing regenerators and an acid bottom. The main feature of this type was a revolving hearth inclined at an angle of 5 or 6 degrees to the horizontal, which turned on rollers at an average rate of three revolutions per minute. The hearth, roller and driving gear were carried on a buggy running on rails, which extended under the furnace and permitted the hearth to be withdrawn for bottom making. The capacity of this

furnace was gradually increased until 15 and 20-ton furnaces were in operation at the St. Chamond Works in 1879.

In the early 80's the Pernot furnaces were run at the Cambria Steel Co. in Johnstown, and also at the works of Spang, Chalfant & Co. at Etna, Pa., but were never introduced to any extent in this country. The principal objections to the Pernot type were: the open joint between hearth and side walls, the difficulty of keeping up the ports, cost of maintenance, heavy loss of iron and excessive erosion of the hearth. Comparatively speaking, very few Pernot furnaces have been used, although at first the short time required to make a heat seemed a great advantage.

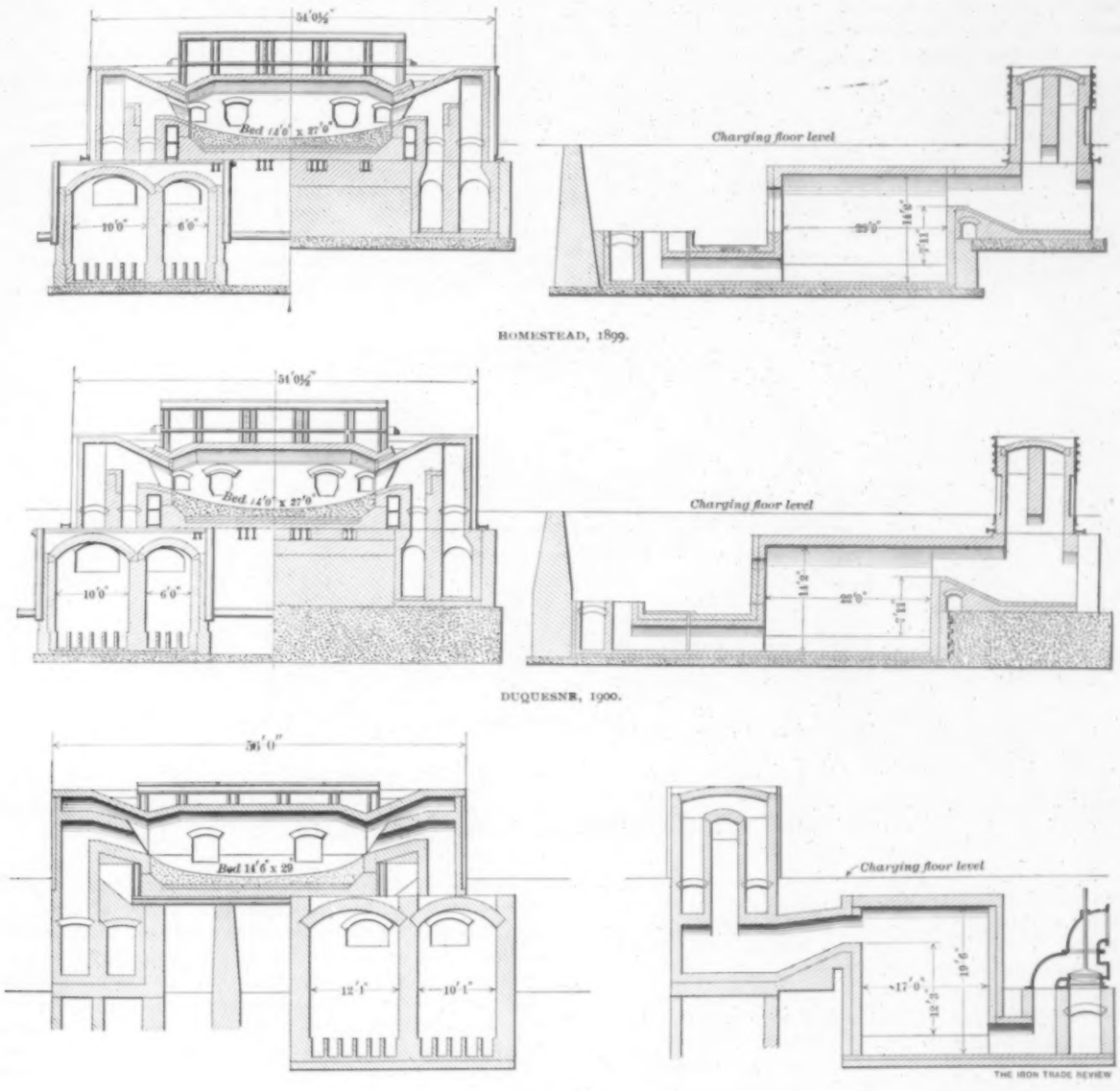
The Ponsard furnace, experimented with in the early 70's, was the first of many unsuccessful attempts to combine the Siemens and Bessemer processes by introducing tuyeres in the Siemens regenerative furnace; the plan being to blow out the silicon and part of the carbon and then complete the reduction as in ordinary Siemens furnaces. All attempts, however, to introduce blasts into the Siemens furnace have only ended in spoiling two good processes.

From time to time furnaces have been built with movable roofs in order that pieces of scrap, which are too large to be charged through the doors, such as old rolls, might be picked up by a crane and charged in at the top of the furnace. These are usually of the Riley type and the round roof is elevated either by screws or hydraulic cylinders and then run to one side, being connected to rollers on an overhead track. Furnaces of this kind still exist and prove very useful in disposing of certain kinds of scrap.

Campbell and Wellman Tilting Furnaces.

The introduction of the tilting furnace was considered to have solved many of the difficulties incidental to the solid hearth type. The first furnaces of this class were designed by H. H. Campbell and Henry Aiken, two of 15 tons capacity being installed at the works of the Pennsylvania Steel Co. at Steelton, Pa., in 1890. These furnaces revolved about their own axes and were provided with rocker bars traveling on live rollers set between the lateral confining plates of curved rails, and when the furnace was rotated, the gas and air ports were partly closed. The tilting of the furnace was accomplished by means of an hydraulic cylinder in a horizontal position connected by links to the frame of the furnace and provided with a cross head. In order that the motion of the furnace should be entirely free, a small space was left between the furnace and the ports, both of which were faced with cast iron water cooled rings. As more furnaces of this type were installed the size was increased, and at present there are 10 tilting furnaces at Steelton, 6 of which are of 50-ton capacity.

Another design of the tilting furnace type was that of Mr. S. T. Wellman's. These were first introduced at the Standard Steel Works, Burnham, Pa., where in 1894 one 15-ton furnace was installed, while in 1895 two 30-ton and four 50-ton furnaces were erected at the South Chicago Works of



HOMESTEAD, 1899.

DUQUESNE, 1900.

SHARON, 1901.

Fig. 4.—Modern Furnaces (1899-1901) of 50 Tons Capacity.

the Illinois Steel Co. Unlike the Campbell furnace, which rotates on its own axis, the Wellman furnace rocked forward, the furnace being carried on two steel castings with circular faces, which rolled on horizontal standards. In order to tilt the furnace, two hydraulic cylinders on trunnions were employed, situated in an approximately vertical position on the tapping side of the furnace, the ends of the piston rods being connected with the main frame. Furnaces of this type of 50-ton capacity are now in use; those designed for the Tennessee Coal, Iron & Railroad Co.'s works at Ensley, Ala., (1899) being fitted with a forehearth provided with two nozzles and stoppers. The furnace, having been tilted, the steel can be poured directly into the molds without using the ladle. With both the above mentioned types of tilting furnaces the movable port, invented by Mr. C. E. Stafford, president of the Tidewater Steel Co., has been largely used.

The Wellman Charging Machine.

One of the most important changes that has been made is in the method of charging the furnace. When this is done entirely by hand or with the aid of light swing cranes to aid in charging heavy pieces of scrap, it is not only a very laborious but a very lengthy operation. Both of these difficulties have been largely overcome by the introduction of the Wellman charging machine. The first machine designed by Mr. Wellman was installed at the works of the Otis Steel Co. at Cleveland, O., in 1887. The movements of the peel were obtained by means of hydraulic cylinders, and the longitudinal travel of the machine was effected by means of a steam winch situated at the end of the charging platform and the boxes were keyed to the peel by hand. This machine was not satisfactory, and Mr. Wellman in 1894 designed and constructed another at Thurlow, Pa., in which all the movements, except the box locking device, were electrical. The parts of this machine were not properly balanced. The weight of the loaded box was not counterbalanced by the controlling apparatus, and when the peel with its load was fully extended, the main frame of the machine was not sufficiently heavy to form a proper base. The operator's platform also was not directly behind the peel, as in the case of the later machines, and therefore the operator could not see to advantage. In the machine designed two years later, these defects were remedied. The charging carriage was suspended from a truck running on rails situated on an overhead frame-work. This frame-work was carried by four columns erected at the corners of the machine and extended in front of the main body almost to the furnace. The weight of the peel and loaded box were counterbalanced as much as possible by the operator's platform carrying the controlling mechanism. The latest design is a return to the low type of machine, as originally used at Thurlow. The charging carriage is mounted between two girders which form the main frame of the machine, and supported by four wheels running on rails fixed to the lower flanges of the girders. Below the upper flange of each girder is an angle which serves as an upper guide for the wheels and keeps the carriage in place. The weight of the carriage is carried by an axle rigidly fixed to the forward set of wheels and the radial motion is obtained about this as an axis, the motion being accomplished by means of a motor-driven crankshaft, the crank arms of which are connected to the rear wheels of the machine by means of a pair of rods, thus obtaining a vertical motion equal to twice the throw of the crank.

Methods of Casting.

The matter of charging having been touched on, let us turn for a moment to the tapping side of the furnace. The methods of casting the steel in the early open-hearth plants varied greatly, but in most of the plants arranged by C. W. Siemens, the furnaces were in line with the casting pits back of them, or in a double line with the pits between and were served by overhead traveling cranes, driven by means of a square shaft, for the handling of the ingots, molds, etc. At Sireuil the steel was poured without the use of a ladle, the ingot molds being placed on trucks running on a track before the furnace and at a lower level. These trucks could be moved forward so as to bring the molds successively under the pouring spout or forehearth, which was supplied with a stopper in order that the stream might be shut off when shifting molds. The modification

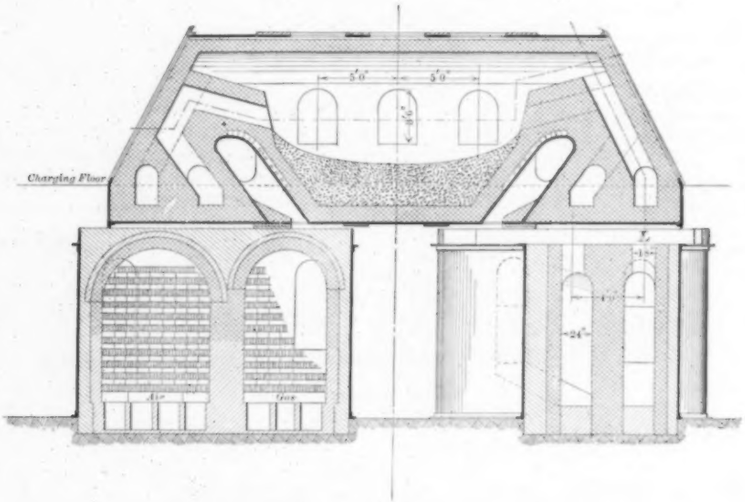


Fig. 5.—First Wellman Rolling Furnace, Standard Steel Works, 1894.

of this system at Terre Noir consisted in a round casting table carrying the molds, which was rotated in order to bring the molds under the pouring trough. Another arrangement adopted by the Landore Siemens Steel Co. and others was to tap the steel into a ladle carried on a truck, which could be moved above a line of molds set in the pit between the rails on which the truck traveled, these casting pits being also served by overhead cranes. Hydraulic casting cranes are used at some works, as are also locomotive cranes.

At present the plants which have been installed for some time are usually arranged with hydraulic casting cranes situated between and serving two furnaces, while the newer plants have large overhead electric cranes running over the ladle pits between two lines of furnaces, which take the ladle direct from the pit to the pouring platform.

A large number of minor improvements have been made in the fittings of the furnace, such as water cooling of doors and door frames, which add greatly to the life of these parts and also to the comfort of the workman; the substitution of hydraulic and pneumatic door lifts for the old counterbalanced door, the hydraulic system being generally preferred; mushroom water-cooled valves in the place of the old butterfly valves, etc.

Acid and Basic Bottoms.

Dr. Siemens, recognizing the value of a basic slag, during his first experiments attempted to use a basic bottom. Va-

rious materials were tried, among which were shrunk lime, magnesia and bauxite, the last having been suggested by M. Le Chatelier. None of these, however, were satisfactory, owing to the heavy repairs required, and therefore acid bottoms were generally adopted. For this purpose ground ganister mixed with a more argillacious sand, or a sand which in itself carried 3 or 4 per cent of alumina, was found most suitable, and practically no change has been made in the composition of the acid hearth up to the present time. It was some time after the introduction of the open-hearth process before any appreciable tonnage was made on a basic hearth. The first authoritative article relative to dephosphorizing on a basic hearth was that written by M. D'Elafond in connection with the operation of the Creusot Furnaces, and published in the Annales des Mines 1882 (Vol. 2, Page 366). But the basic process was not introduced into England on a commercial scale prior to 1885, although for a number of years before a few basic furnaces had been operated on the Continent.

The first basic steel made in the United States was produced under the direction of Mr. S. T. Wellman at the works of the Otis Steel Co., Cleveland, Ohio. One furnace with a Spater magnesite bottom was started Jan. 19, 1886, and operated until April 6 of the same year, making

tice, it was customary to ram the bottoms in, but later it was found that burning them in gave much better results.

Another bottom which is very good but expensive is that made of chrome ore ($FeO\text{-}Cr_2O_3$). This bottom was introduced by Valton and Remaury and a patent was granted them for the same in 1883 (French patent No. 154,372). The chrome ore is not ground and rammed in, but is laid like a stone wall in large pieces held together by a cement composed of pulverized chrome ore and 5 per cent of lime or dolomite. The side walls also are usually built up within ten inches of the skew-back with lumps of chrome ore put together in the same manner as the bottom. The neutral bottom has been used at various places in France, among which were the Fourchamboult and Alais Steel Works, but this method of construction is found chiefly in Russia, and the first use of the bottom on a large scale was at the Alexandrofsky Works in 1880. At the time of the writer's visit in 1899, the furnaces at the Alexandrofsky, Pontiloff, Kolpino, and Obeuhoff Works, in all 23, ranging from 8 to 20 tons capacity, were working on chrome ore bottoms, as were also the furnaces at the Briansk Works in the District of Odessa.

In England and France the number of acid bottoms is largely in excess of the basic, while in America and Germany the basic hearth is generally employed.

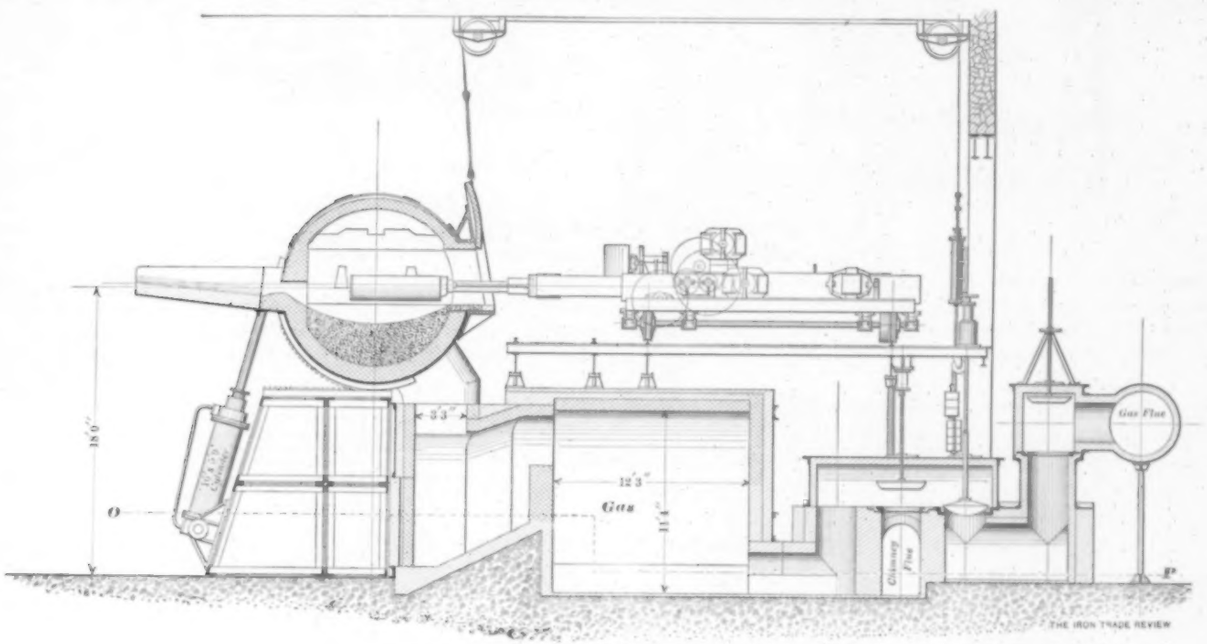


Fig. 6.—First Wellman Rolling Furnace.

something over 1,600 tons of ingots. As this was the first trial on a basic bottom in this country, the results were not altogether satisfactory, and the company being pressed for steel the basic bottom was taken out and the acid bottom replaced. This furnace was probably the first having vertical regenerators under the charging floor, which is a characteristic of the modern furnace.

In 1888 the Carnegie Steel Co., at their Homestead Works, were the first to take up the manufacture of basic steel in this country on a large scale. Various materials have been used for basic bottoms. In Germany and America, where the basic process developed most rapidly, dolomite was generally employed. In the early German practice, rammed bottoms of dolomite mixed with anhydrous tar were most common, although magnesite, dolomite, or limestone mixed with milk of lime for a binder, were also used; these bottoms being generally separated from the silica side wall by a layer of magnesite or chrome brick. Magnesite bottoms, although comparatively little used at first, owing to their expense, have become more and more popular, and at present, especially in America, the bottoms are of magnesite, repairs being made with dolomite, and frequently the banks are made against the silica brick side walls without any intermediate layer of neutral brick. These magnesite bottoms, while expensive, are very satisfactory. In the earlier prac-

Furnace Charges and Manipulation of Metal.

The open-hearth process as at first operated in France by Emile and Pierre Martin consisted in obtaining a bath of melted pig and then dissolving in it malleable iron scrap which, in the preferred practice, was pre-heated in an auxiliary furnace before being added to the molten pig. At times the pig and scrap were charged together cold and then melted. In England, however, the process, as carried on by Siemens was to make the initial charge entirely of pig and when melted to reduce the carbon by successive additions of ore.

For a number of years only relatively high carbon steel was produced, the necessary carbon being obtained by either tapping the heat when it had arrived at the proper carbon or partially recarbonizing with spiegeleisen. Prior to 1877 the bulk of the product was used in the manufacture of rails

For some time after spiegeleisen was employed, it was thought that its function was only that of a recarbonizing agent and that the required hardness of the rails was obtained by the addition of pure high carbon pig iron, but no consideration was given to the fact that possibly the manganese addition played an important part. Therefore the manufacturer in attempting to produce soft steel reduced the spiegel addition to the smallest possible percentage in order

to obtain a low carbon product. This was an impractical operation, for in case the heat was more or less oxidized, the result, in absence of manganese, was a red short and practically worthless steel.

Sir Henry Bessemer noticed that the metallic manganese produced by Heath was an important adjunct in cheapening the production of steel and was led to believe that by the introduction of a small amount of ferro-manganese, sufficient manganese could be supplied for the necessary reduction of the oxide of iron in the heat and very much lower carbon steel produced. Mr. Bessemer then took the matter up with Mr. Henderson at the St. Rollox Chemical Works at Glasgow, who finally succeeded in producing ferro-manganese (containing 25 per cent Mn.) in an open-hearth furnace with a bottom composed of carbon bricks; this product being commercially introduced in 1866-1867.* It was not generally adopted, however, partly because its value was not realized by many steel producers and partly because of its high price. The natural result was that its manufacture was soon abandoned in England, but shortly after it was taken up by the Terre Noire Works in France and there made a success, this being largely due to the efforts of the engineer in charge, Mr. Walton, who, appreciating the value of ferro-manganese, bought both the patents of Henderson and Prieger. The product was then improved so that ferro-manganese containing 50 to 60 per cent manganese was soon placed on the market.

The operation, however, was still carried on in the Siemens furnace and was therefore very expensive. It was not until ferro-manganese was produced in coke furnaces, furnished with the Cowper or Whitwell stoves, that the price materially decreased; and the experiment made at Terre Noire in 1875 with a blast furnace, which had been producing 40 or 50 tons per day of Bessemer pig, was the first step in the right direction.

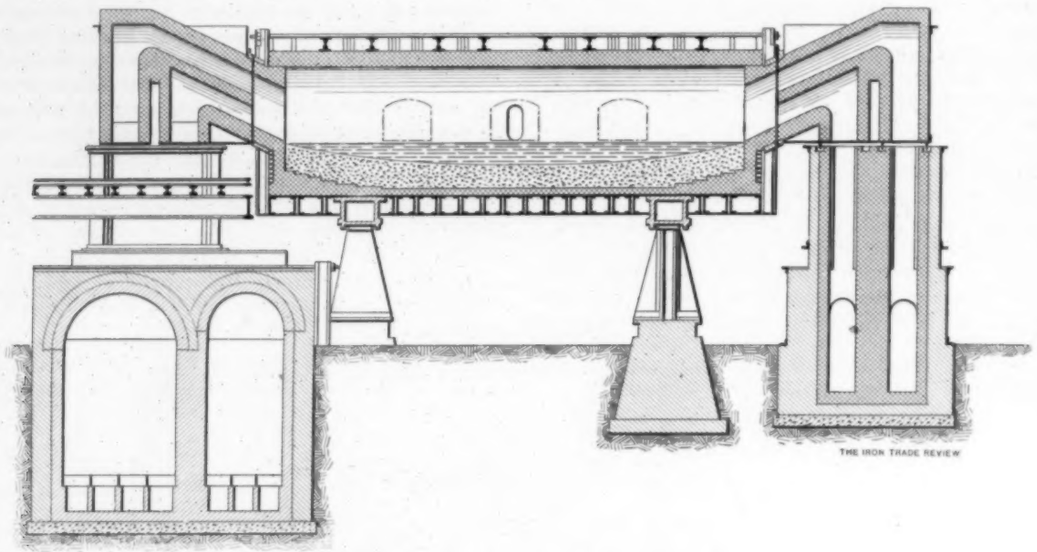


Fig. 7a.—Modern Wellman Rolling Furnace.

This furnace had a blast temperature of 1100° Fahr. and a pressure of 5½ inches from three tuyeres, and produced from 10 to 12 tons of ferro manganese (60 per cent manganese) per day. From this time the percentage of manganese was gradually increased until a product containing from 80 to 82 per cent manganese could be regularly produced, at what was then a moderate price. The production of ferro-manganese at a reasonable price was the most important step in the development of the open-hearth process next to the introduction of the regenerative principle, as it enabled the manufacturer to produce dead soft steel and enter the field previously occupied by wrought iron.

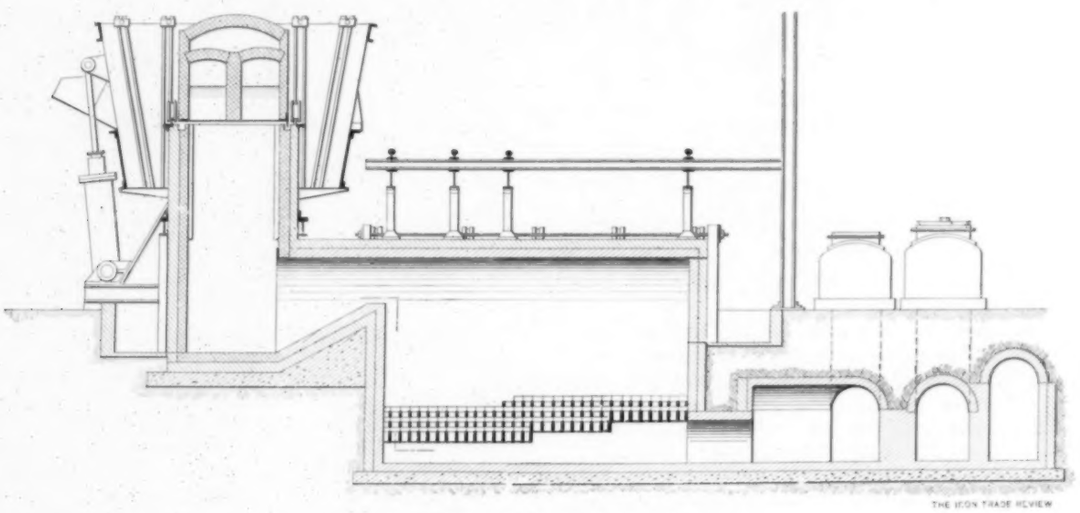


Fig. 7b.—Modern Wellman Rolling Furnace.

The recarbonization of the steel, when being tapped from the furnace, by the addition of coke or anthracite coal was another important improvement in the process of manufacture. As early as 1871 Sir Henry Bessemer described a method of carbonizing pig metal and steel, by subjecting such metal in closed vessels to the action of incandescent carbon (U. S. Patent 117,507). In 1889 Darby obtained a patent for

*During the same years that Mr. Henderson was operating his process at Glasgow, German periodicals mentioned the process of Dr. Oscar Prieger of Bonn, who was manufacturing at Cologne 75 per cent ferro-manganese in crucibles.

re-carbonizing by pouring the molten metal through a mass of carbonaceous material (U. S. Patent 406,430), and in 1890 Spannagel and Springorum introduced a method of adding free carbon to the metal, which consisted in causing a regulated stream of pulverized coke to flow from a hopper and mix with the stream of molten metal (U. S. Patent 430,199). With the above methods, however, the amount of carbon introduced into the steel was very uncertain. In 1890 Taylor Allderdice of Pittsburg conceived the idea of putting the coke in paper bags, each containing a definite amount, and introducing these into the stream of molten metal (U. S. Patent 491,035). The result was very satisfactory, as the percentage of carbon in the steel was then well under control, the steel absorbing practically 50 per cent of the carbon contained in the coke or anthracite coal.

The fuel in general use is ordinary producer gas, but in the Pittsburg district the furnaces are run with natural gas, in which case both the regenerators are connected to the air valve. The natural gas contains, on an average, about 93 per cent of CH_4 and the calorific power is from 7½ to 8 times that of producer gas. Furnaces have also been operated with oil fuel or water gas, and the first furnaces erected in Sweden used wood fuel in the producers; but this was very extravagant, as the weight of the fuel consumed was about 2½ to 3 times the weight of steel produced.

From the time the open-hearth process was introduced practically all the steel was made from charges containing pig and scrap, together with more or less ore, depending on the percentage of pig metal used. This practice, largely owing to the difference in time rquired to make a heat, was found to be more economical than the pig and ore process of Siemens and was threfore generally adopted. At the present day a charge usually contains from 40 to 60 per cent of scrap.

Many attempts have been made to produce iron and steel direct from the ore, among which the Siemens and Adams-Blair processes were probably the most widely known, but no direct process has been successful from a commercial standpoint.

Use of Direct Metal—Pig and Ore Processes.

In the ordinary open-hearth practice both the pig and scrap are charged cold, and it is a curious and interesting fact that until within the last few years no decided effort has been made to charge the pig metal in a molten condition direct from the blast furnace, although the use of molten metal was suggested very early in the history of the process, as is witnessed by the fact that the Landore-Siemens Works was designed in 1872 with the evident purpose of using direct metal. The use of molten metal was also suggested by Mr. Jules Petin, in 1874, and from time to time its use was attempted by other manufacturers, but no practical results followed. In June, 1897, the Carnegie Steel Co. started to operate twelve 40-ton furnaces, using 50 per cent molten pig and 50 per cent scrap, the results being so satisfactory that the practice was continued; and at present a number of works in both Europe and America are charging molten pig metal. Within a decade various combination pig and ore processes have been introduced, their object being to obtain one or more of the following advantages:

1st. Shorten the time of a heat.

2nd. Dispense with the use of scrap.

3rd. Allow the use of impure pig.

4th. Obtain a certain amount of steel direct from the ore.

Among these processes the following may be mentioned: At Witkowitz, where the pig obtainable contains too little phosphorus for use in the basic Bessemer and too much to be used in the acid Bessemer, the operation is as follows: Pig containing about one per cent silicon is run from the blast furnace into a ladle and transferred to an acid Bessemer converter, where the pig is desiliconized. The metal, still containing some manganese and considerable carbon, is then poured into the ladle and transferred to the basic open-hearth

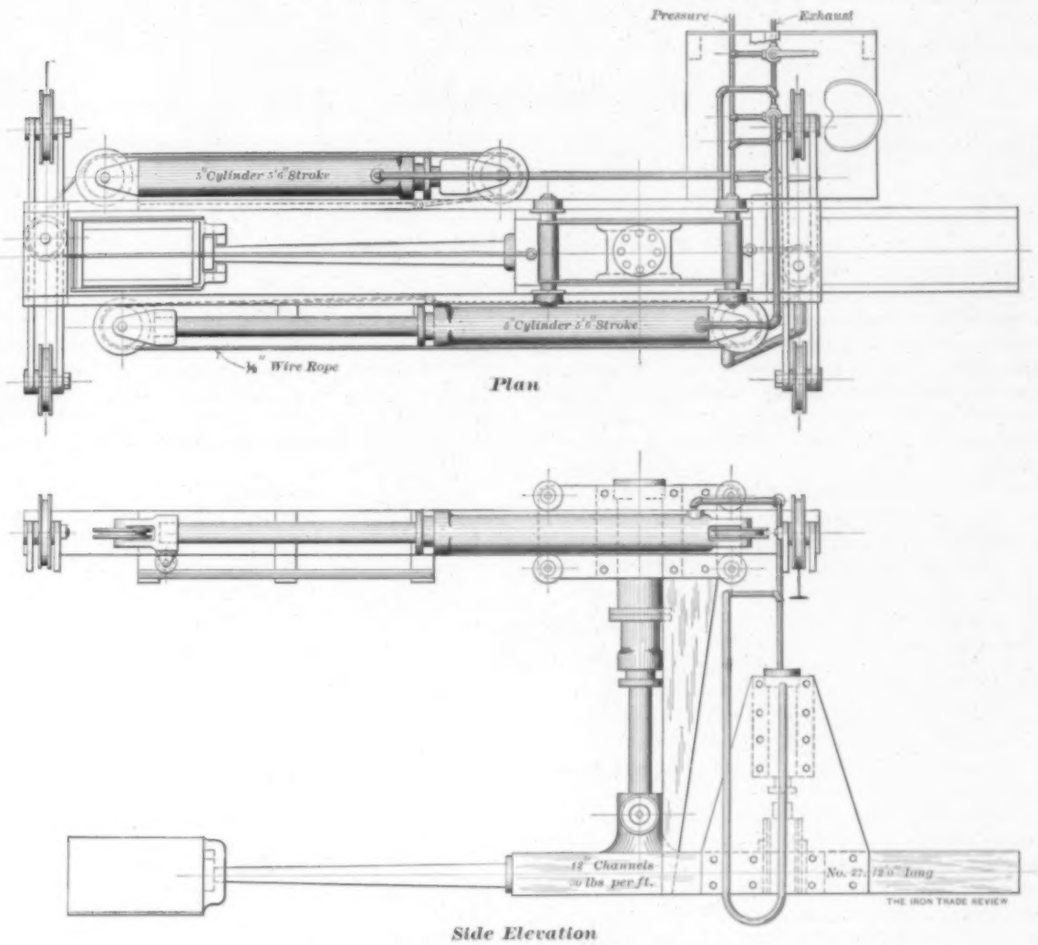


Fig. 8.—First Wellman Charging Machine, Hydraulic.

furnace, where it is dephosphorized and decarbonized. The above process has been in operation since 1890.

The combination process introduced by Mr. Arthur Richards at Bolckow Vaughn & Co.'s and operated for a short time early in 1899 consisted in charging low phosphorus pig in an acid lined converter, blowing out the silicon and manganese and reducing the carbon to about .50. Two blows were then run into a 25-ton acid furnace, slag being placed on the bottom where the metal strikes, in order to prevent cutting. The heat was then worked down to .10 carbon in about two hours.

Bertrand-Thiel, Talbot and Monell Processes.

The Bertrand-Thiel process was put in operation at the Kladno Works (Bohemia) of the Prager Eisenindustrie Gesellschaft in 1894, and according to Mr. Joseph Hartshorn* of Philadelphia "consists essentially in dividing the charge between two furnaces, tapping the metal from the upper into the lower one, and removing the slag from the metal during its progress from one furnace to another. Both furnaces are at work on the basic system, although this is not an essential feature of the process. Pig iron high in silicon and phosphorus is charged into the upper furnace with a small portion of the scrap, if desired, and also a certain quantity of ore and limestone. The remainder of the scrap is charged into the lower furnace, together with pig iron and a small quantity of limestone. A little ore is also added, if necessary. The upper furnace is first charged, and the metal is melted and made hot. This takes about three hours. By the end of this time the metal is hot and fluid, the silicon is all in the slag, and the carbon and phosphorus are to a considerable extent eliminated. It is then ready for tapping. The lower furnace is charged about two hours later than the upper one. By the time the metal in the upper furnace is ready for tapping, the metal in the lower one is also a fluid.

"The primary furnace is then tapped, the slag being carefully skimmed off the metal as it passes down the trough and prevented from entering the secondary furnace. As soon as the two metals mix together a very lively reaction ensues, which quiets down in about a quarter of an hour. The phosphorus is then below 0.03 per cent in the bath. The heat is finished by addition of ferro-manganese or spiegeleisen, and is ready to be tapped if no further improvement in quality is desired. Fifteen minutes longer in the furnace brings the phosphorus below 0.02 per cent." Since 1896 experiments have been made running these furnaces on pig and ore without scrap, the pig in some cases being charged cold into the primary furnace and in others charged in a molten condition direct from the blast furnace.

The Talbot continuous process has been in operation since September, 1899, at the Pencoyd Steel Works. The novel feature of the process consists in retaining a portion of the finished steel in the furnace. It is described by Mr. Talbot† as follows:

"The furnace in use is a basic-lined tilting-furnace of 75 tons capacity. The pig iron to be converted has an approximate composition of—

Carbon.	Silicon.	Sulphur.	Phosphorus.	Manganese.
3.76	1.00	0.06	0.90	0.40

Owing to the absence of blast furnaces, this pig iron has to be melted in cupolas. The furnace should be charged on Sunday evening with about 50 per cent of scrap, and this first (or filling) is worked down to steel in the usual way. When the bath is good finished steel, about one-third of it is poured off into a ladle and cast into ingots. No slag is run off with the steel. After tapping off this one-third of the charge, oxide of iron in a fairly fine state of division is added to the slag, and as soon as this is melted about 20 tons of molten cupola metal are run in to replace the steel tapped out. And immediately a very active reaction takes place, during the continuance of which the gas is cut off from the furnace. The reaction has all the characteristics of the Bessemer blow during the elimination of carbon, a large volume of CO being given off, which immediately ignites and burns with an intense flame, the heat thus produced partly raising the temperature of the bath and partly being absorbed by the regenerators. After the metal has boiled vigorously for some ten or fifteen minutes, the slag, which is now almost deprived of iron oxide, is partly poured off, and the bath worked down into finished steel by the help of fresh additions of iron ore and lime. When the bath is ready one-third (or about 20 tons) of steel is cast, fresh slag additions are made, and another 20 tons of molten cupola metal run in as before. These operations are continued during the whole of the week, the furnace being completely emptied only on Saturday."

The Monell pig and ore process* was introduced at the Homestead Works of the Carnegie Steel Co. in February, 1900. It enables the manufacturer to dispense with steel scrap and to produce steel from pig and ore as rapidly and economically, and with as great an output per furnace as with

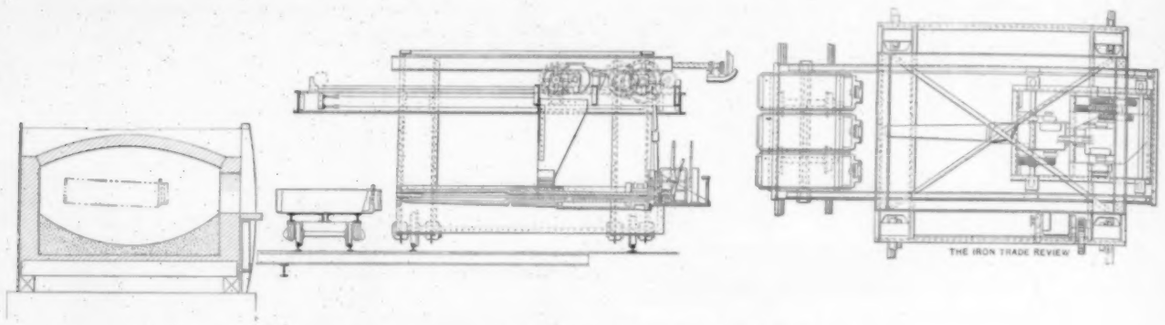


Fig. 9.—Wellman High Type Electric Charging Machine.

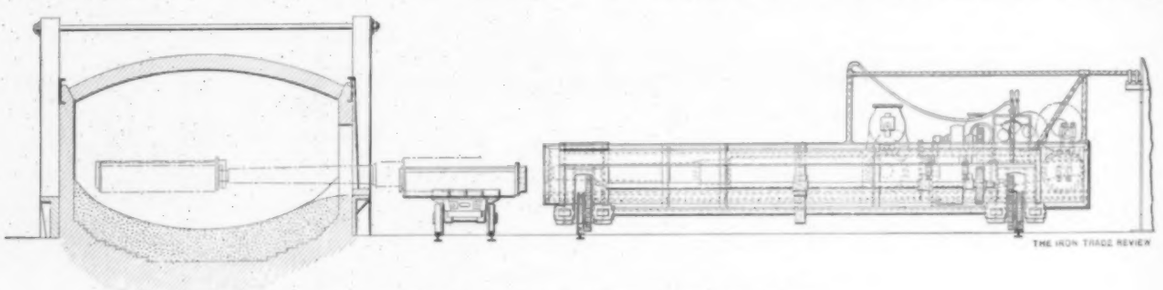


Fig. 10.—Wellman Low Type Electric Charging Machine.

*Transactions American Institute of Mining Engineers, Sept., 1896.

†Journal of Iron and Steel Institute, Vol. 1, 1900.

*Iron Trade Review, May 31, 1900.

charges containing 50 per cent scrap. The process consists in charging in a basic open-hearth furnace limestone and a relatively large quantity of ore, heating these, and then charging molten pig metal taken from a mixer or direct from the blast furnace. The temperature of the resulting mixture must be low enough to insure rapid oxidation of phosphorus. The slag formed rises and is drawn off at a cinder notch, taking with it practically all the phosphorus and silicon. Within an hour after charging the molten pig, the bath is free from phosphorus, silicon and manganese, and the bulk of the slag containing these impurities is removed, while the carbon in the bath is still high. The bath is then in the best possible condition to be acted on by the flame and remaining ore which has not yet been reduced. The steel may be tapped when the carbon has reached the desired point. Either mill scale or tap cinder may be substituted for the ore, and the proportion of oxide may be varied according to the percentage of carbon desired in the finished product.

The process may be operated in any ordinary basic furnace by simply cutting a cinder notch in the back wall, which means that the number of furnaces in a plant running on pig and ore may be changed at a moment's notice, as the cinder notch in no way interferes with the working of an ordinary pig and scrap heat.

Increase in Open-Hearth Tonnage.

Prior to the introduction of the basic hearth, the tonnage of open-hearth steel was comparatively small, the acid furnaces not being generally adopted, as their cost of production was considerably above that of the Bessemer converter. The basic bottom, however, enabled the manufacturer to employ cheaper grades of pig iron, which were too high in phosphorus for the acid Bessemer and too low for the basic Bessemer process. This reduced the price of open-hearth steel very nearly to that

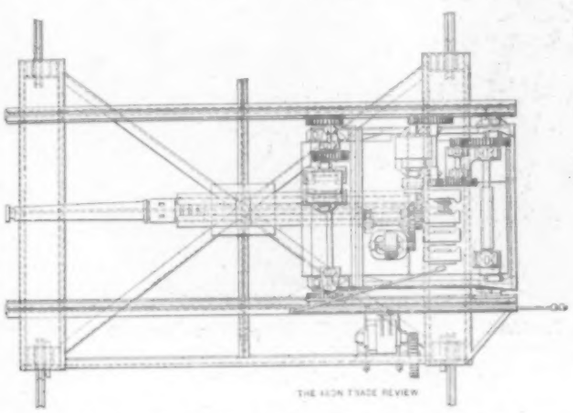


Fig. 11.—Plan of Wellman Low Type Electric Charging Machine.

of Bessemer and opened to it many markets which had been closed to the high-priced acid open-hearth steel.

In Sweden the furnaces are small, ranging from 5 to 15 tons capacity, the product being used for special purposes, while in France, although the furnaces are larger, the tonnage of open-hearth steel produced is less than the tonnage of puddled iron, this being probably due to the comparatively small number of billet mills supplying the trade.

In relation to the total amount of steel produced, the open-hearth process has not progressed as rapidly in America as in Great Britain, as there more steel is made in the open-hearth than in the converter, while in this country, Bessemer steel is largely in excess. This difference is no doubt attributable to the large amount of low phosphorus ore available in America, and also to the fact that in this country the bulk of the tonnage is represented by rails, sheet bar, wire rod, skelp, hoops, bands, cotton ties, agricultural steel, etc., practically all of which is made from Bessemer steel, while in Great Britain the open-hearth plates and shapes used in shipbuilding constitute a large percentage of the total product.

A few figures will suffice to illustrate how rapid has been the increase in production of open-hearth steel. In the United States, for instance, in 1879, there were only 20 furnaces, the largest of which held but 12 tons; in 1898 there were 281 furnaces erected, many being of 40 to 50 tons capacity. The weight of open-hearth ingots produced in this country in 1879 amounted to 52,290 tons, but by 1900 this had increased to 3,402,552 tons*. In 1879 Great Britain produced approximately 175,000 tons of open-hearth ingots against 3,156,050 tons† in 1900.

The writer thanks Mr. S. T. Wellman for the illustrations accompanying this paper.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.

(*Portraits on Page 48.*)

That so great an industrial center as Pittsburg and the immediate vicinity should have a technical and educational organization representative of its varied industries, the Engineers' Society of Western Pennsylvania was formed in 1879 and incorporated one year later under the laws of Pennsylvania. With a view to admitting to membership the varied engineering talent at work in developing these industries a unique organization was formed—one that permits the enrollment of civil, mechanical and mining engineers, geologists, architects, managers and superintendents of railroads, mills and manufactories and other persons engaged in scientific and mechanical pursuits. It was natural, with the iron industry predominant in the district, that a majority of the membership, since the birth of the organization, should have been drawn from the engineering staffs of the great steel plants, and that much of the literature contributed should be on topics pertaining to the manufacture of iron and steel.

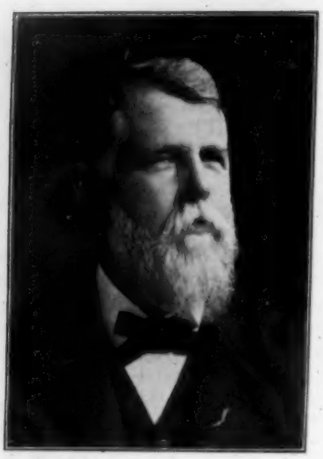
Among many notable men whose names have been on the membership rolls at various times are Andrew Carnegie, Charles M. Schwab, James Hemphill, George H. Clapp, Samuel Diescher, I. W. Frank, Frank Hoffstot, A. E. Hunt, B. F. Jones, F. B. Laughlin, M. K. Moorehead, George G. McMurtry, F. B. Nimick, Samuel Rea, George Reiter, W. C. Reiter, Joshua Rhodes, John Ricketson, A. L. Schultz, T. S. Scott, G. H. Singer, W. H. Singer, James P. Witherow and William Metcalf.

In 1879, James H. Harlow, at that time assistant United States Engineer at Pittsburg, realizing the necessity of some kind of an engineering organization, called a meeting of all the engineers of the Pittsburg district to take steps for the formation of a society. The conference was held at the office of Alexander Dempster, engineer of the city of Pittsburg, on Dec. 15, 1879. Forty persons were present, William Metcalf was chosen chairman and James H. Harlow, secretary. A committee was appointed to draw up a constitution and by-laws and at the next meeting held on Jan. 8, 1880, in the rooms of the common council, officers were elected and a constitution and by-laws adopted. William Metcalf was chosen president, James H. Harlow, secretary, and William Kent, treasurer. On March 20 1880, a charter was granted the society by Judge E. S. Stowe. The applicants were William Metcalf, A. Gottlieb, Thomas Rood, E. M. Butz, N. M. McDonald, William Kent and James H. Harlow. The membership at the start was 156. The first paper read before the body was presented by William Metcalf on the question "Why Does Steel Harden?"

Owing to the large number of chemists affiliating with the organization it was decided to form a separate section for them and on May 24, 1892, the chemical section of the Engineers' Society of Western Pennsylvania was organized. While allied with the main society its members maintain a separate organization and meetings are held monthly, the fourth Tuesday of the month, while the meetings of the main body are held on the second Tuesday of the month. Papers are regularly presented at these meetings on questions in chemistry. In order that all the members, whether present at meetings of either the main society or the chemical section or not, the Journal of the society was founded on Jan. 17, 1893. Ten issues are published each year and they contain all the proceedings, papers and discussions of both bodies.

The present headquarters are at 410 Penn avenue, Pittsburg. The rooms are sumptuously furnished and the meeting room is well adapted to the needs of both bodies. The society's

* American Iron and Steel Association Reports.
† British Iron Trade Association Reports.



James H. Harlow, One of the Founders.

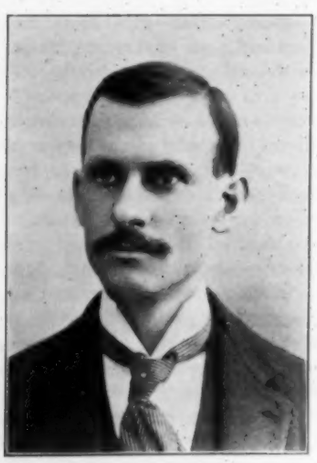
Chas. F. Ridinger, Secretary.

A. G. McKenna, Chairman of Chemical Section.

A. Gross, Secretary Chemical Section.

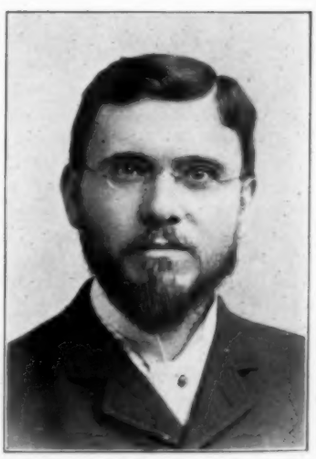
H. W. Fisher, President.

F. C. Phillips, Vice-President.



Chas. F. Scott, Vice-President.

A. E. Frost, Treasurer.



K. F. Stahl, Vice-Chairman Chemical Section.

OFFICERS OF THE ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.

library is very valuable and numbers several thousand volumes. The headquarters have been changed many times. During the year 1880 the meetings were held in the rooms of the Pittsburg Chamber of Commerce and those of the Western Iron Association. During the next three years the meeting place was the gallery of the Pittsburg Public Library and the following year in the rooms of the Iron and Steel Association. The rooms were re-engaged for the next three years and in 1888, 1889 and 1890 the headquarters were located in the Penn building. The following two years rooms were secured in the Arcade of Science and in 1893 and 1894 the Thaw Mansion served as headquarters. During the next two years meetings were held in the Carnegie Library, Allegheny, Pa., and in 1896 headquarters were established at the present location. The next removal will probably be to the association's own home, as a fund with this end in view has been started and already amounts to several thousand dollars.

Below we give a chronological list of the officers of the society from the date of organization to the present time:

Year.	President.	Secretary.	Treasurer.
1880-1	Wm. Metcalf.	J. H. Harlow.	Wm. Kent.
1881-2	Wm. Metcalf.	J. H. Harlow.	A. E. Frost.
1882-3	A. Gottlieb.	J. H. Harlow.	A. E. Frost.
1883-4	A. Gottlieb.	J. H. Harlow.	A. E. Frost.
1884-5	Wm. Miller.	J. H. Harlow.	A. E. Frost.
1885-6	Geo. H. Brown.	W. F. Zimmerman.	A. E. Frost.
1886-7	E. B. Taylor.	S. M. Wickersham.	A. E. Frost.
1887-8	Alex. Dempster.	S. M. Wickersham.	A. E. Frost.
1888-9	Alex. Dempster.	S. M. Wickersham.	A. E. Frost.
1889-90	J. A. Brashear.	S. M. Wickersham.	A. E. Frost.
1890-1	W. L. Scaife.	S. M. Wickersham.	A. E. Frost.
1891-2	T. P. Roberts.	J. H. Harlow.	A. E. Frost.
1892-3	A. E. Hunt.	R. N. Clark.	A. E. Frost.
1893-4	M. J. Becker.	R. N. Clark.	A. E. Frost.
1894-5	Chas. Davis.	Daniel Carhart.	A. E. Frost.
1895-6	T. H. Johnson.	Daniel Carhart.	A. E. Frost.
1896-7	W. G. Wilkins.	Daniel Carhart.	A. E. Frost.
1897-8	Emil Swensson.	R. A. Fessenden.	A. E. Frost.
1898-9	G. S. Davison.	R. A. Fessenden.	A. E. Frost.
1899-00	H. J. Lewis.	R. A. Fessenden.	A. E. Frost.
1900-1	W. A. Bole.	R. A. Fessenden.	A. E. Frost.
1901-2	H. W. Fisher.	C. W. Ridinger.	A. E. Frost.

The chemical section has had the following officers.

Year.	Chairman.	Secretary.
1892-3	J. W. Langley.	J. O. Handy.
1893-4	J. H. Eastwick.	Fred Crabtree.
1894-5	W. E. Koch.	A. T. Eastwick.
1895-6	J. M. Camp.	A. D. Wilkins.
1896-7	J. M. Camp.	A. G. McKenna.
1897-8	W. E. Garrigues.	A. G. McKenna.
1898-9	J. O. Handy.	A. G. McKenna.
1899-00	E. S. Johnson.	A. G. McKenna.
1900-1	J. O. Handy.	A. G. McKenna.
1901-2	A. G. McKenna.	A. Gross.

The membership of the society has grown greatly since its organization and today the enrollment is about 450. The membership of the chemical section is considerably over 100.

Love Brothers, Aurora, Ill., founders and machinists, are erecting new buildings of larger dimensions and more modern equipment.

The Shelby Steel Tube Co. has discontinued its sales offices in The Rookery, Chicago.

The Illinois Stove Co., St. Joseph, Mich., has been incorporated in Illinois with a capital stock of $2,500.

R. M. Eddy Foundry Co., 69 Indiana St., Chicago, is contemplating an addition to its plant, 50x100 feet.

The Chicago Boiler Cleaner Co., with offices at Chicago, Pittsburg and St. Louis, has sold its good will and business to the Liberty Mfg. Co., with ofhces same as heretofore.

An error was made in a recent reference in these columns to the Bellefontaine Bridge & Iron Co., of Bellefontaine, O. The company was incorporated on May 12, 1890, or about 11½ years ago, instead of 1½ years ago as stated. Recently the company installed an electric light plant and it is now running night and day with a large force. Its principal operations are in highway bridges, but all forms of structural work in wrought iron and steel are done.

THE LATE JAMES HEMPHILL.

The great plant of Mackintosh, Hemphill & Co., of Pittsburg, stands as monument to the untiring energy and effort of James Hemphill, who died at his home in Pittsburg, on Aug. 7, 1900. As a builder of heavy duty engines for rolling mill and blast furnace work his reputation was world-wide, while rolling mill machinery turned out at this plant is installed in all the largest steel plants in this country and England.

Mr. Hemphill was born in Mechanicsburg, Cumberland County, Pa., July 22, 1827, and lived there until 1846, when his parents removed to Tarentum, Pa. As a boy he drove a cart, and at an early age was apprenticed to a blacksmith. In 1850 he went to Pittsburg and secured employment with Joseph French, then engineer of the Pittsburg water works. When Mr. French was appointed superintendent, Mr. Hemphill succeeded him as engineer. About 1857 he invested a little money in a machine shop, located in the abandoned steel works of McKelvey & Blair, standing on a site afterwards occupied by Hussey, Wells & Co. In 1859 he withdrew from the partnership and joined with W. S. Mackintosh and

James Hemphill.

H. F. Hart in a machine shop at Twelfth and Pike streets. From this humble start the Fort Pitt Foundry of Mackintosh, Hemphill & Co. has grown.

As an engineer Mr. Hemphill was noted for the massiveness and solidity of his work. He was wedded to the idea that a rolling mill engine should run with the least possible number of breakdowns and that the economy of fuel was secondary. The reversing blooming mill which Mr. Hemphill forced to the front, until today it is a fixture in all steel plants, is one of the greatest of the achievements in his career. The first mill of this kind which he built was installed in the plant of the Bessemer Steel Works, the plant from which the great Homestead Works of the Carnegie Steel Co., at Homestead, Pa., has risen. Reversing mills of this kind had been made before, but all proved failures until Mr. Hemphill with his courage and effort put his shoulder to the wheel and turned failure into success. One of the first reversing mills installed in this country was put into the plant of the Freedom Iron & Steel Co., Lewiston, Pa. This proved a failure and was not operated any length of time. To Mr. Hemphill was taken the design of the first Garrett rod mill. He predicted its success and built the stands for the first installation. In 1893 Mr. Hemphill retired, his place in the firm being filled by his sons.

What the Engineer Has Done for the Foundry.

BY DR. R. MOLDENKE.

Of all the branches of the great iron industry the engineer has been made least welcome in the foundry. Wherever we look we find monuments of his genius, but here, in what may be truly called an essentially important part of the world's resources for manufacturing, the skill of the engineer is not as yet fully exploited. However, the work that has been done, even if indirectly, is being appreciated more and more daily, and the day is not far distant when new foundries of any importance will necessarily be built and operated by techni cally trained men.

Richard Moldenke.

Contrast the typical foundry of a generation ago with one of today and great strides will be seen. Where competition is not the keen incentive to progress we will still find tumbledown buildings and crude appliances. But even those foundries of today which boast of their independence of trained talent have owners who are careful to select only the best types of machinery and the most economical furnaces possible, all of which have been practically developed by the mechanical or metallurgical engineer.

It will be found that the prejudice against the technical man which was still to be seen a decade ago in the very pursuits which have established our country's industrial supremacy—this prejudice will give way even in the foundry ere long, and the latter will then reach its fullest development and importance as a factor in this age of iron.

It is an interesting task to follow the engineering development of the foundry. To start with the buildings which house the various departments of the business, we find that two causes have assisted in their improvement. The demands of the fire risk and the fact that many foundries are adjunct to other institutions, which could value engineering talent. The result is a fine array of buildings of stone and brick, with slate roofs on iron trusses. Where the requirements of the business warrant it we find buildings all iron and provided with runways for the traveling crane. The structural engineer then has given the foundryman a workshop of maximum usefulness at as low a first cost as is consistent with the service requirements.

In the matter of elevators, the old runway for the pig iron and coke barrows, as well as the several stages which served for the upward movement of the charge by manual labor, are slowly giving way to modern fairly high speed lifts. Whether the hydraulic, electric, or steam elevator be used depends upon the kind of power best available in the shop. Here again it will be noted that the engineer has developed for us methods of transmitting the power stored in coal, oil and gas, either by direct explosion or through the agency of steam or compressed air. These methods are now so perfect in their economy or ease of application that it is not difficult to decide upon the system best adapted to the locality and the work. It may be many generations before the world will realize to what extent it is indebted to the men who have enabled us to conserve our natural resources today as we never have before.

This question of power transmission is an interesting one in the foundry. One who has seen long lines of light shafting, possibly set off at various angles with noisy bevel gear, or occasionally bowed out dangerously by the accidental shifting of a roof support, will know how to admire the electric motor. Today we have many foundries in which the patternshop, elevator, yes, even the fan, is run by electricity. The beauty of this system lies in its ease of application, its great efficiency, and today we may also say cheapness.

This brings us to the cranes. Whether jib or traveling, whether in metal yard or foundry proper, we have now a means of applying power in a most universal manner to the moving of pig iron, flasks, cores, ladles full of iron, scrap and finished castings, at will. The kind of crane to be used naturally depends upon the class of work turned out. One can, however, hardly imagine a better equipped foundry than one with two electric traveling cranes on the same runway, each with two hoists. Then also a number of movable post cranes of the jib type fitted with air hoists.

W. J. Keep.

Here also must be remembered the numerous systems for carrying iron, either overhead or along the foundry floor. The first named are now made so flexible that they leave little to be desired, and are a fair substitute for the traveling crane when the superstructure prevents its use. The air hoist also plays an important part when an overhead track system is available. Not only ladles full of melted iron may be moved about from the cupola to

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DR. MOLDENKE is one of the few men who have found a fascination in studying the peculiarities of cast iron. Most of the emphasis has been put on steel in the chemical and metallurgical research of the past two decades. Dr. Moldenke has brought the same scientfic method to the study of cast iron from the standpoint of the chemist, metallurgist and testing engineer. He was born in Watertown, Wis., in 1864, and received his early school training in New York. He graduated from the Columbia School of Mines in 1885, with the degree of engineer of mines, and two years later received the degree a doctor of philosophy from the same institution. His next few years were devoted to gaining experience in the field, the U. S. Coast and Geodetic Survey, and sanitary and electrical engineering claiming most of this time. A call to the chair of mechanical and electrical engineering at the Michigan College of Mines was accepted in 1889. A year later Dr. Moldenke returned to active work in the foundry industry. The ten years following were spent with the McConway & Torley Co., of Pittsburg, in malleable work, and in 1899 Dr. Moldenke with others, organized the Pennsylvania Malleable Co., of Pittsburg, which has at McKees Rocks one of the most extensive plants in the country. The death of his father-in-law compelled the giving up of the superintendency of this concern, and Dr. Moldenke removed to New York to look after the financial interests of the estate. He is now in the directory of several large manufacturing and mining companies. The greater part of his time is devoted to foundry work, particularly to the secretaryship of the American Foundrymen's Association, to which he was re-elected in 1900, and re-elected in 1901. Dr. Moldenke gives in the journal of the association the result of much research and a digest of the foundry literature of two continents. His work on the A. F. A. committee on standards for testing cast iron was conspicuously able.

WILLIAM J. KEEP, of Detroit, is descended from Puritan stock and from John Keep, who came from England to Massachusetts in 1660. He was educated at Oberlin, and at Union College in Schenectady, N. Y. where he graduated, taking the degree of civil engineer. Before going to Union College to fit himself for a mechanical engineer, he learned the trade of a machinist at the Globe Iron Works of Cleveland. After graduation he took charge of the stove works of Hubbell & Brother, of Buffalo, and two years later became superintendent of the stove manufacturing plant of Fuller, Warren & Co., of Troy, N. Y., acting in that capacity until 1876, when he engaged in the same line of business on his own account. For several years after removing to Troy he gave a course of lectures on the steam engine to the senior class of the Rensselaer Polytechnic Institute. Since 1884 he has been general superintendent of the Michigan Stove Co.'s works at Detroit.

Mr. Keep is a fellow of the American Association for the Advancement of Science, a member of the American Institute of Mining Engineers, American Society of Mechanical Engineers, and was one of the committee of the last named society on standard tests and methods of testing materials. He is also a member of the Iron and Steel Institute, the International Association for Testing Materials, American Foundrymen's Association, Franklin Institute, and has been president of the Detroit Engineering Society. He is an honorary member of the Rensselaer Society of Engineers, and of the Philadelphia Foundrymen's Association. He is the author of a large number of scientific papers, most of which may be found in the transactions of the above societies.

Mr. Keep has written a book, "Cast Iron," now in press (John Wiley & Sons, New York), and to be issued in a few weeks. This will give the results of his research and experiments with this material. Mr. Keep is the manufacturer of a line of testing apparatus, which is now in use in a large number of foundries in this country and in Europe.

the remotest floor, but cores, finished molds and castings can be made to go by regular schedule in a well planned system.

The work of the mechanical engineers may be seen in still other directions; for fans, blowers, tumbling barrels, and grinding machinery may now be bought of most excellent pattern and high efficiency. Indeed, to eliminate machinery from the foundry today would straightway bring us back to the days of Tubal Cain.

Thos. D. West.

The metallurgical engineer has not been idle, either, as a stately array of furnaces and cupolas give proof. The open-hearth furnace, with its gas firing, is being constantly improved in its adaptability to various branches of the iron and steel industry, and we may still see the day when the foundry will have adopted it wherever excellence in product is the prime desideratum. The tendency to specialization, with practically continuous runs of uniformly heavy tonnages, will induce foundrymen to take advantage of the economy of the open hearth furnace. The iron will also come out better, as it will not be exposed to oxidizing influences as long as in the air furnace now used so much.

Of the cupola little may be said. The double row of tuyeres, when properly designed and used, is quite efficient. The ease of manipulating the cupola process, and its cheapness, is such that it will always be used for making the bulk of the world's castings, for the deteriorating influence of the blast and direct contact with the fuel is covered up by the great factor of safety inseparable from the design of every day jobbing work.

Perhaps the most important improvement in the foundry proper, and one which aims at the basis of the whole industry is the introduction of the molding machine. We are merely seeing the beginning of an era of specialization in which machine molding will play a most important part in the foundry. It is not necessary to trace the development of this special feature of the foundry business here; but enough is now known of the capabilities of the molding machine, that only the most difficult and ponderous castings seem without its reach. Pneumatic rammers and a much wanted pattern-lifting device will inevitably make the use of some form of machine molding essential everywhere.

Attention must be called finally to the tendencies of the foundry business. We are all familiar with the solid ground gained by the use of science in manipulating mixtures. Further progress in this direction is still much wanted as well as a more universal understanding of cause and effect. The success of the industrial engineer in bringing the foundry as a whole upon a higher plane is most notable, for many are the instances of plants conceived and built upon lines which rival the best organized establishments now in existence in other admittedly advanced lines. We find as the basis of these foundries the use of extensive carrying systems which handle fuel, sand, iron, and other raw materials. Then also cores, finished molds, castings, scrap, etc. Adjustability and an interlocking, as it were, are so provided for that manual labor is reduced to a minimum. The production per man employed is therefore very heavy. Pipe, radiators, fittings, railroad specialties, and the like, are now produced in this way in great quantities, and at a remarkably low cost.

The foundry then has much to thank the engineer for, and the best way to do this would be to help him still further to harness the forces of nature in its behalf, and thus strengthen the position the making of castings now holds in the world's industries.

PROBABLY NO ONE has done as much as Mr. West in the creation of a literature of the American foundry—of foundry operations and foundry processes. He has been indefatigable as an investigator, and though starting without the advantages of training at school, has advanced himself by his own efforts to a position of prominence in his chosen work. He was born in Manchester, Eng., in 1851, and in that year his parents removed to New York. At eight he lost his father, and two years later he was at work in a foundry. His experience has been largely in heavy-weight work, and at an early age he had charge of important operations involving engine and saw mill machinery castings. After an extended career in the East Mr. West entered the foundry of the Globe Iron Co., Cleveland, having charge of work on steamboat cylinders and heavy machinery. Later he was foreman of Wm. Tod & Co.'s foundry at Youngstown, O., but returned to Cleveland to become manager of the Variety Iron Works foundry. Mr. West and a partner built a jobbing foundry in Cleveland in 1887; in 1892 it was burned down. The rebuilt plant was located at Sharpsville, Pa., and the T. D. West Foundry Co. was organized to make a specialty of ingot molds. This concern turns out from 70 to 100 tons at a heat. Mr. West's works are well known and have had a wide circulation. They are "Molder's Text Book," "American Foundry Practice" and "Metallurgy of Cast Iron." A new edition of the last named, with extensive revision, is now in press. He has contributed numerous papers embodying the results of research to the various foundrymen's associations. He is in charge of the American Foundrymen's Association bureau for standardizing drillings, whose work has done much to secure uniformity and accuracy in chemists' work on pig iron and cast iron, and was chairman of the committee on standardizing the testing of cast iron, whose work has been so valuable to the foundry world.

GEORGE P. MAURY.

George P. Maury, manager of the Metallurgical Laboratory, of Pittsburg, is a Kentuckian by birth, and received his early as well as technical education there. He began his early engineering career as an ax-man with the Birmingham Mineral Railroad engineer corps. His advancement was rapid, and later he became constructing engineer with the DeBardeleben Coal & Iron Co., in charge of their blast furnace work. In 1890 he became resident engineer for the Virginia Development Co., with headquarters at Max Meadows, where he constructed water works, a short line railway, and had direct supervision of the blast furnace construction of the company. Believing that a successful engineer should have a thorough knowledge of chemistry, Mr. Maury entered the University of Virginia as a student, taking a course in applied chemistry, graduating in 1893. He was at once appointed assistant chemist of the Dora Furnace Co., and later became chief chemist of the Buena Vista Iron Co. In 1896 he was appointed assistant chemist of the Edgar Thomson Works of the Carnegie Steel Co., at Braddock, Pa. He was later sent to Virginia City, Minn., by the Carnegie Steel Co., in the capacity of chemist for the Mesabi range properties. Resigning this position, he was appointed assistant chemist of the Newburg works of the American Steel & Wire Co., at Cleveland, O., and also served as chief chemist at their Allegheny, Pa., plant. In March, 1901, he became manager of the Metallurgical Laboratory, which position he now holds.

George P. Maury.

Owing to the breaking down of the blooming mill in the Bessemer plant of the Republic Iron & Steel Co., Youngstown, O., the plant will be shut down for several weeks. A new engine is being built for the blooming mill and will be ready for installation shortly.

The Rogers Locomotive Works of Paterson, N. J., has been reorganized by its late purchasers under the name of the Rogers Locomotive Co. Officers were elected as follows: John Havron, president; E. H. Norton, vice-president; F. P. Holoran, treasurer; G. E. Hannah, secretary; Reuben Wells, general manager, and Hon. John W. Griggs, counsel. The directors are Sir William C. Van Horn, G. B. Hopkins, George Turnue, J. D. Probst, E. C. Smith, F. P. Holoran, John W. Griggs, R. C. Purin, E. H. Norton, John Havron and Stephen Peabody.

Some Examples of the Evolution in Machine Tool Practice.

By ROBERT I. CLEGG.

It needs no study of the files of technical journals, interesting as such an investigation would be, to learn something of the lines upon which the machine shop industry has developed. There are shops and shops. Some have seen a steady growth in progressive methods and management while others have maintained less power to assimilate and utilize the improvements brought forward from time to time by inventors. For this reason it is not absolutely essential that the history of any single progressive machine shop be studied in order to trace the steps in the evolution. These are indicated clearly enough by the less progressive and enterprising establishments to be found in the vicinity. Each of these marks a stage in the development of the new order of things.

One of the most striking differences between the old and the modern method of procedure is the intense concentration of purpose. The oldtime shop could make everything and manufacture nothing. The latter-day shop manager limits his field of effort to the production of a single line of machines

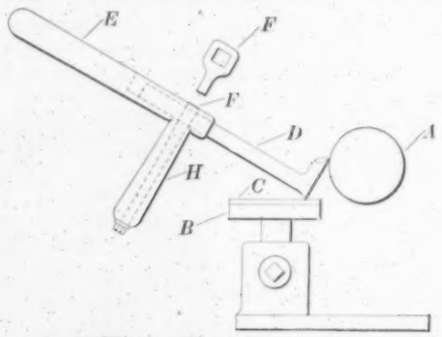


Fig. 1.—Lathe Work. Hand Tool for Heavy Cups.

and has as few sizes as possible. The varied accomplishments of the old shop that at the pleasure of anyone were focused upon the tinkering of an engine or the grinding of a skate, the making of a pump or a loom, have not been discarded entirely, but are now brought to bear with all obtainable force and persistency in the production of the one thing. It may be a drill press or a lathe, or merely a part of some machine; but in the means to produce it with a minimum expenditure of time and physical effort all the experience and ingenuity of the past has been applied.

Two Factors in Modern Machine Production.

It will be seen from this that there are two tendencies in modern machine production that frequently fail to receive popular consideration. There is less need of sheer brute force: the carving of material into shape is no longer a matter of brawn, first and foremost, but largely one of brains. The operator is now the director of a machine in which is combined in enduring form the muscular capacity of many machinists. The cutting of dies for stamping irregular shapes is often pointed out as an instance of laborious hand work and it is likely that it will remain so pending the introduction of a die metal that will be more easily pressed into the desired form. The bulk of the cutting, however, is now readily performed by the milling machine with a rapidity and ease that have hastened the introduction of press work and cheapened the cost of hardware generally. The second tendency has been to an increase of skill. There is a popular belief that the introduction of labor-saving machinery has lessened the opportunities for skilled labor; that there is now less chance for the artist and the craftsman when a machine will turn out thousands of duplicates of the article that either of these could produce singly in the same time with an infinitude of pains. No one but a politician would advocate the breaking of trap rock by hand for the public roads. A single machine would perform this task in a manner that would put a crowd of street laborers far behind in the race; and the same condition confronts whoever fairly considers the machine in any other field of human enterprise.

The modern lathe with its gear feeds and its micrometer attachments is much more labor-saving than the old chain operated tool with its wooden frame and cone. Few machinists of the present day have handled a tool of the latter sort and fewer still would care to repeat their experience. The uneven chain would stretch and kink in a manner that

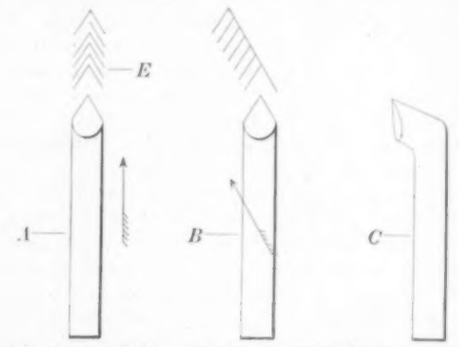


Fig. 2.—Lathe Work. The Use of the Compound Rest.

would put the workman on the rack of a wearying anxiety. The cutting of threads was a hand process that survives to this day in many sections abroad: the stock roughed down with a shoulder tool and the thread started with a diamond point held in the same primitive style. A chasing tool was then employed to bring the thread to the common standard of the shop. Good work was done with these rude appliances but it was slow and uncertain. The shoulder or heel tool is illustrated in Fig. 1. A is the stock, in section, on the lathe centers. B is the cast iron rest, sometimes shod with a harder material on the surface at C. D is the cutting tool, forged out of square steel and having a point to rest against the surface at C. The wooden handle has a square groove to fit the tool shank and the latter is held in place by passing through an eye-bolt F, the latter being secured by a nut and washer at G.

The tool was operated by placing the handle E against the shoulder, one hand grasped the other handle at H and a firm grip was maintained on some convenient part of the machine, usually the round portion of the rest below B. Now with feet braced firmly and planted some distance apart, the point of the tool was applied to the work and an attempt made to pare off a slice of the material. The rotating piece

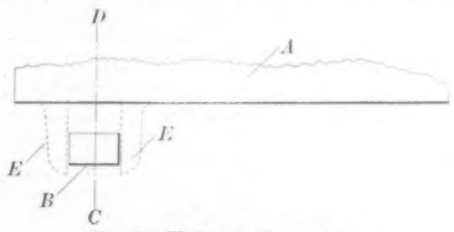


Fig. 3.—Tailstock Convenience.

in the lathe would be uneven, of course, on the surface but, unlike our present opportunities in this direction, the interior of the piece would be less even than the outside and hard and soft places with an occasional layer of grit in the wrought iron would test the sand of the machinist. The leverage of the work was apt to drag the tool into the material unless complete command was retained over the action irrespective of the varying strains.

There was little or no provision for cutting tapers. For

such a purpose the cross-feed was moved in or out at a certain rate dependent upon the hand of the operator keeping pace with the rotation of the work and the travel of the carriage along the bed of the lathe. A mark on the circumference of the work was a guide as it repeatedly came in sight for the hand of the workman to match the rotations of the cross-feed screw. The rotating work had often an additional check in a tune, more or less melodious, whistled by the machinist in time to the action of the machine. Sometimes the taper, particularly if it was an internal operation, was roughed out with hand tools and finished with a side tool in the same manner.

The Modern Contrast.

Contrast this rude method with present-day methods and equipment. The wooden beams have given place to the strongly ribbed cast iron bed and positive action in every way. The tool is now rigidly held without tension on the operator so far as constant muscular effort is concerned; the lathe screw is conveniently attached to the carriage at will and is easily copied with a facility in the choice of variations upon the pitch. The substitution of one gear for another, usually a grimy procedure, bids fair to become one of the cleanest operations about the lathe. The change gears on many lathes are now arranged in sets around a circular cage or on a shaft, so that the setting of a lever completes the operation of changing the pitch ratio of the lead screw to the main spindle. The micrometer adjustments permit a close approximation in setting the tool to cut to size after the first measurements have been taken. The piece is roughed down, measured and the amount to be removed is at once determined and the machine may be set forthwith to the exact position for the removal of the surplus. The old method was a matter of guesswork, assisted certainly by experience, but essentially an experiment, a cut and try affair; the new way boils down the long training of the uncertain process into a matter of easy mental subtraction or addition. The machinist is none the less skillful because the means of attaining the end in view are easier to handle and acquire. He is not so liable to an error of judgment and there is a comforting certitude about the operation that removes directly and indirectly many of the obstacles that otherwise would cause him to hesitate and stumble about his task.

Skill by No Means Dispensed With.

Much of this ability to further the progress of the work depends upon the means at hand for its highest fulfillment and the greater the aptitude of the individual the greater the results and under the pressure of competitive effort, the best man obtaining the greater salary, there is a demand for an increase in the efficiency of the machinist that acts as a premium for the higher skill displayed. It is a mistaken notion that a machinist simply and solely feeds metal into a machine and that it drops out as finished studs, screws, etc., with no attention from the attendant. There are men doing work of a type analogous to this, and they are receiving wages in proportion to the skill demanded in this class of labor. The reason their recompense is small is largely in the fact that they in turn require superintendence and are taxed for its cost. Automatic machinery requires constant supervision, in order that it may sustain its automatic character; and in operation as well as in construction there is a necessity for skilled labor. Skilled labor is after all but the ability to get out of the tools all that they are capable of doing; and this is as true of a well designed and finely finished machine tool as it was in the time when a screw was carved out of the solid with templates, a hammer and cold chisel and a few files.

The cutting of a screw is frequently made more of a task owing to the influence of precedent. Because the majority of lathes have been made without a compound rest is no reason for ignoring the evident advantage given by this device. For example, the thread is usually cut with a tool placed and fed

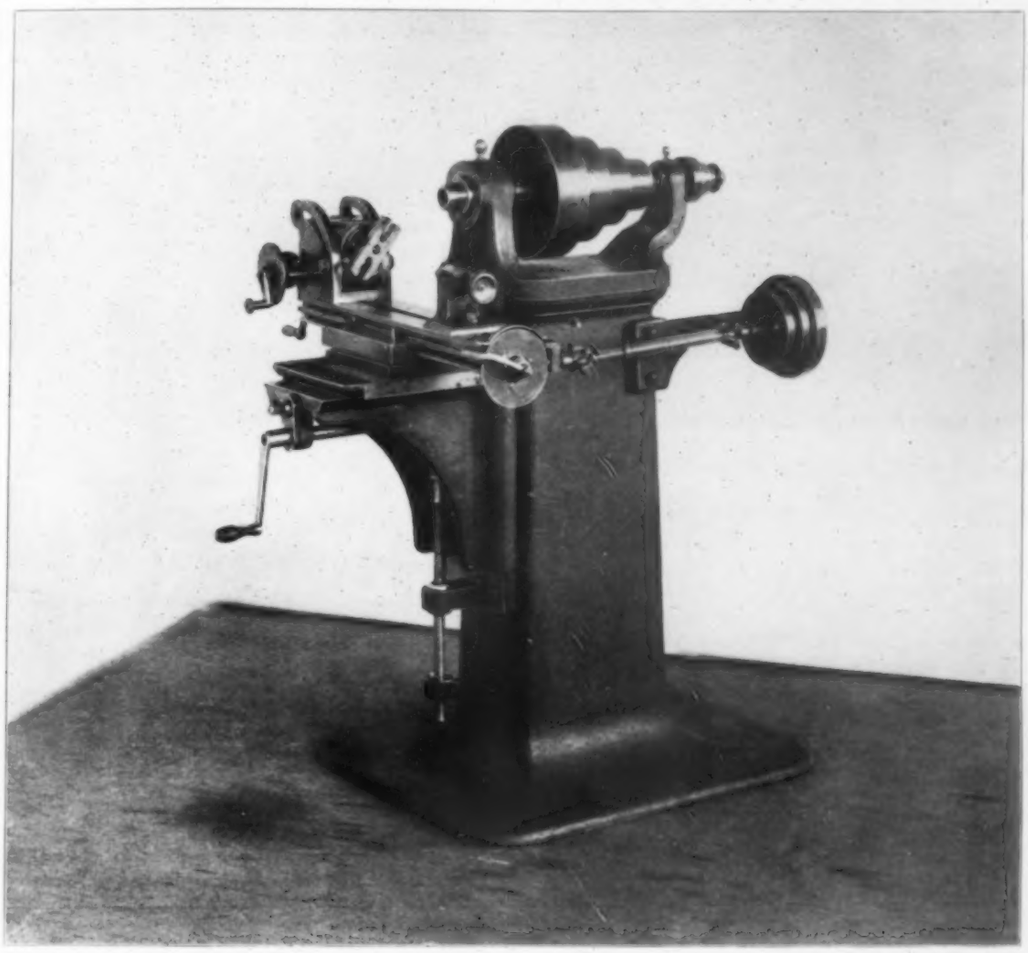


Fig. 4.—Original Universal Milling Machine, built by Brown & Sharpe Mfg. Co. in 1862.

in at right angles to the axis of the centers of the lathe. The cutting edges are at work on the two sides of the V and are about the same height. There is then little opportunity to get a keen cut because the tool lacks rake. The practiced machinist will raise the tool slightly to improve the cut, but his efforts in this direction are manifestly limited. If, however, he has a lathe with a compound rest he can grind the tool to cut on one edge only and feed the tool in at the necessary angle. This is illustrated at Fig. 2. A shows the tool fed in at each successive cut parallel with the cross-feed screw of the carriage in the direction of the arrow. The cuts are made in succession with each lip of the tool; the Vs at E show the result. Compare this with the action illustrated at B. By means of the compound rest the tool is fed in along the line of the arrow and but one lip of the tool cuts at a time, the other being ground away to give the tool a free-

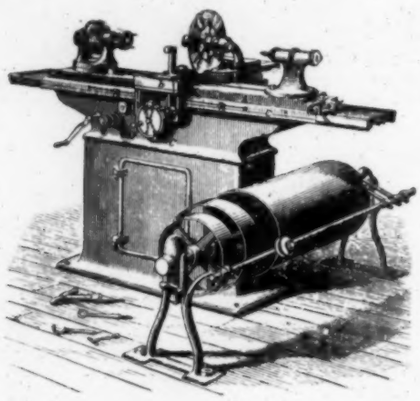


Fig. 5.—First Brown & Sharpe Universal Grinding Machine.

cutting top rake. C is an elevation of the tool seen in plan at B.

A lathe screw is made long enough to cut a thread equal to the greatest distance between the centers and therefore most lathes have the wear of the lathe nut on a small portion of the screw. This leads to an inequality of the pitch as the lead screw wears. Prof. John E. Sweet long ago pointed this out, as well as the importance of having bearing surfaces overlap each other so that they would pass at the end of the travel and thus avoid any tendency to form a ridge or step at any intermediate point. This would call for a nut equal to the length of the lead screw and would be out of the question with the ordinary lathe. Prof. Sweet advises the shortening of the lead screw and mounting it upon a supporting arbor to permit of adjustment to different lengths of threaded work. Whether the increase in accuracy would offset the additional complication is only to be settled by a careful scrutiny of the circumstances surrounding each individual case and requirement.

Early Departures in Lathe Design.

Many years ago Prof. John E. Sweet designed a lathe at Cornell University. The machine was built under the direction of Prof. C. I. King at the University of Wisconsin and is now at the works of the Straight Line Engine Co. at Syracuse, N. Y. It has been thoroughly illustrated in the past and it is not now necessary to do more than enumerate some of the features that are especially noteworthy as examples of unusual design. There is always a strong tendency to follow in the common groove that with certainty leads to working results. Even if the path never gets beyond average conditions safety is preferable to brilliancy as a general rule. There are certain tendencies of modern machine design that are so clearly continuations of the ideas embodied in the above mentioned lathe that a brief reminder of the original work is quite in order. Among the unusual features are the internal back gears, which are wheels and pinions, instead of the ordinary idlers, whereby a difference between fast and slow is nine or ten to one, and the movement of one lever makes the change, the gearing being contained within the headstock. The headstock swings on a pivot for turning tapers and is graduated to read either in degrees or inches to the foot. The reverse for screw cutting is in the headstock and the jaw clutch teeth are so ingeniously arranged that, while there are two teeth opposite, each makes a complete turn before it clutches as is necessary in screw cutting. Ordinarily a clutch with two teeth opposite will clutch at every half revolution. In this lathe, however, the nut can be thrown in or out at pleasure in cutting any screw. At the back of the carriage is a device to withdraw or advance the thread-cutting tool at the right moment, so that the operator need only set the tool for the new cut. The cross and forward feeds are so proportioned that when both are thrown in the tool will turn a 60° center.

The lathe is of the gap type without loose pieces and the end of the bed is designed so that there is nothing in the way of sliding off the tailstock without removal of the bolts supporting the binder bracket. The latter is attached in a manner deserving of general imitation. Like many other points it will not appeal to the ordinary draftsman as it will to the machinist who has endeavored to counteract such a source of occasional annoyance by an expedient of some sort or another. This idea is outlined in Fig. 3. Here a portion of the tailstock is shown at A; the cross piece, or binder clamp is indicated at B. The two are held together by a bolt acting along the line CD. The length of the supporting bolt or bolts is apt to cause a swinging of the clamp B as the tailstock is moved along the bed in changing from one length of work to another—a matter in the majority of shops of frequent occurrence. At these times the clamp is apt to catch against the bed and the machinist registers a resolution, possibly other things, to remove the tailstock at a convenient time in the near future and fit some strips of wood or metal across the casting to hold the bolts in place. This trouble is obviated by extending the base of the tailstock downward as shown by the dotted lines at E E to form a fork at each end

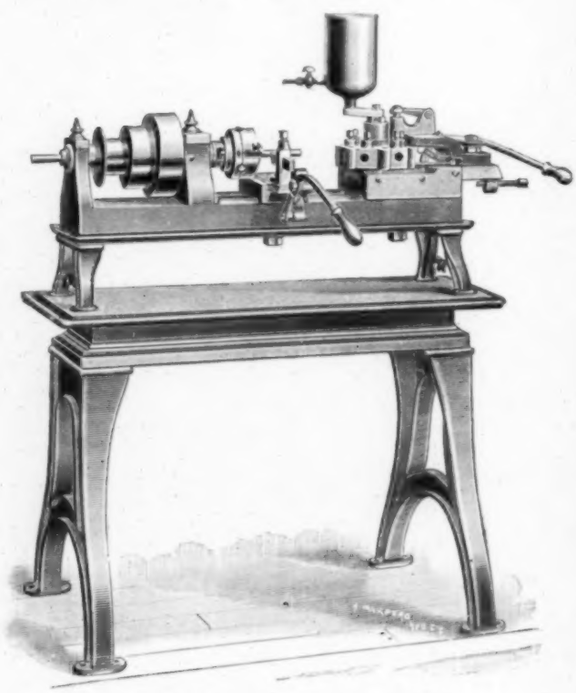


Fig. 6.—Original Automatic Turret Machine.

of the clamp B. The footstock spindle is gripped at both ends by the one motion. The centers can be made to point at each other when turning tapers.

The slide rest is entirely guided by the front V, the rear of the carriage resting on a flat bearing surface. The cross slide and the guide are of equal length. The headstock end of the bed rests on a closet pedestal and the footstock end on a pivoted leg, the pivot being in line with the axis of the lathe bed. This results in a three-point bearing for the machine and avoids any twisting strain being brought upon the bed by means of an uneven floor. The original Lipe tool post was attached to this lathe. It is open at the side for the admission of the tool, instead of the usual slot, and the base of the post is enlarged and fits into a bored recess in a clamping ring on the cross slide. The tool post may thus be easily

raised, lowered or rotated to suit the requirements of the work.

The change gears are all fixed in the headstock and permit 84 different threads or feeds to be cut without changing the wheels. A rod passing through the center of a shaft operates a sliding key as it is drawn in or out. The feature of varying the feed ratios without changing the gears from one shaft to another is being sought by inventors and several highly interesting solutions to the problem have been introduced and applied to lathes in recent years.

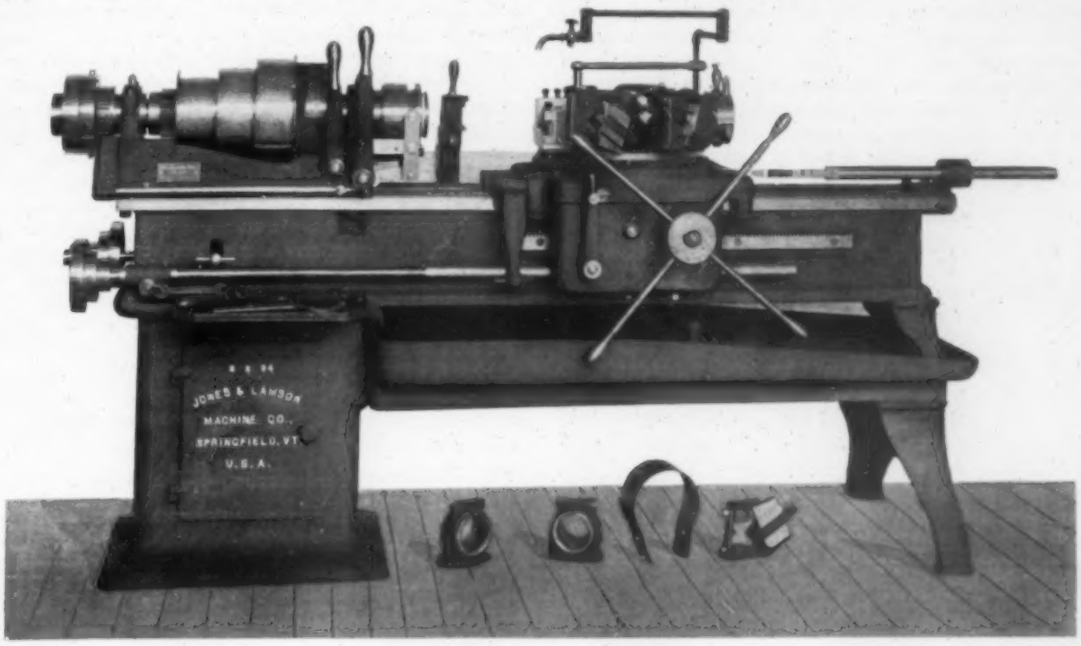


Fig. 7.—Modern Type of Turret Machine.

The Original Brown Milling Machine.

The original universal milling machine designed by J. R. Brown, of J. R. Brown & Sharpe, built in 1862 and patented in 1865, is shown herewith, and as compared with the modern machine demonstrates that while there have been great improvements in construction, the fundamental principles have continued on the lines embodied in this pioneer effort. The later improvements have been rather along the line of strengthening the older machine to resist successfully the strains introduced in present day manufacturing processes. Some conveniences have, of course, been applied: the single cranked handle for the cross slide and the elevating screw is replaced in the modern machine by the hand wheel, and the two shafts are separated at their outer ends so that the two hand wheels will not interfere and may be constantly in position. Improvements in the manner of connecting the feeds by means of a moveable plug or latch, instead of the shifting of a belt along a pair of stepped cones, as has been the case with the lathe, is a feature more frequently found. The hole cut through the base and the two lower bearings for the elevating screw have merged in a single bearing projecting upward from the bed, and in a number of cases the addition of a double or differential screw has enabled the same length of travel to be performed by the knee without an extension of the screw through the floor. The overhanging arm serving as an outer bearing to the main spindle, and the use of back gears, are essential in the heavy duty now customary; but for light work, particularly tool room purposes, this old machine was exceedingly useful and its rapid adoption undoubtedly opened the way for the subsequent development of labor-saving machinery in the machine shop and elsewhere. The spindle can be placed in a vertical position by the designer and the change results in a very convenient arrangement of the milling cutters in die and profile work.

Fig. 8.—A Modern Machine Shop and Its Motto.

The milling machine leads naturally to the cutters. These were in the first place formed with numerous teeth on the supposition that the greater the teeth in action the more material could be removed in the same time. The cutters had the teeth relieved sufficiently to cut, but ordinarily no attempt was made to preserve the form of the teeth as they were sharpened and the proximity of the adjoining cutting edges was a bar to the use of any but a thin wheel between the teeth. Sharpening a milling cutter often meant annealing the whole thing and filing up the teeth to the original size and cutting condition. This obstacle to the economical use of the milling machine was duly recognized by Messrs. Brown & Sharpe and in 1864 the now well known form of milling cutter that can be sharpened without changing the outline was patented. This was first made and introduced on the cutters for the teeth of gear wheels.

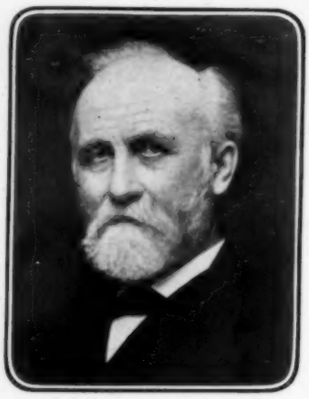
Evolution of Grinding Machines.

The universal grinding machine was designed by J. R. Brown, of Brown & Sharpe, and patented in February, 1877. We illustrate the old machine as manufactured by that company. This had the familiar devices for taper and dead center work. An additional movable table, capable of adjustment by a tangent screw, and graduated arc, permitted straight or taper grinding with the centers of the machine always in line, the feed works and the slides of the machine being covered and fully protected from grit and dust. The tool had a family likeness to more modern tools in its general lines and later developments have been in the direction of heavier construction and greater range. The introduction of grinding processes has been retarded to some extent by the analogy drawn between its purpose and that of the file as well as the fear that the deformation of the metal by the heat generated in grinding, added to the fragile character of the abrasive wheel, would render accurate work a tedious and uncertain task. In reference to the first objection it may be pointed out that realizing the difficulty of attaining good work with the file has always meant that the amount to be removed by that tool should be as small as possible. The lathe tools accordingly have been ground and set with that idea in mind and the feeds arranged to correspond. So closely was this custom followed in the preparation of surfaces to be ground that it piece would be turned down to within three one-thousandths (.003) of an inch of the size to which it was intended to be ground and the anxiety consequent upon leaving a smooth surface for the grinding machine and at the same time maintaining these narrow limits was a great impediment to the progress of the work. Grinding is now performed with an abundance of water and free cutting wheels adapted to the character and shape of the material. The trouble incident to rapid removal of metal is minimized by heavier machines and abrasive wheels capable of higher duty. Lately Mr. Norton, of the Norton Emery Co., has carried the investigation of the subject of heavy grinding far ahead of the position previously held and by the aid of rugged machine tools specially adapted to carry out his conclusions has obtained remarkable results.

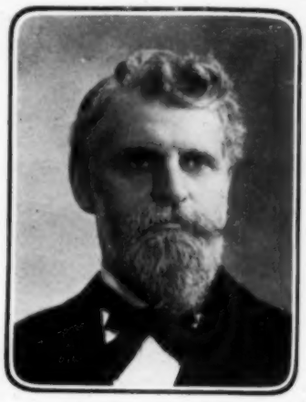
The Introduction of the Turret.

The turret machine is an outgrowth of the lathe, being a

The Late Joseph R. Brown.



John E. Sweet.



Ambrose Swasey.

JOSEPH R. BROWN, in conjunction with his father David Brown, laid the foundation of the Brown & Sharpe Mfg. Co. in Providence, R. I., more than half a century ago. In 1833 a co-partnership was formed between the father and son. In 1841 David Brown retired and the business was then conducted by J. R. Brown until 1853, when Lucian Sharpe became his partner and the firm of J. R. Brown & Sharpe was formed. It was incorporated in 1868 as the Brown & Sharpe Mfg. Co. Joseph R. Brown was born in Warren, R. I., Jan. 26, 1810. He attended the district school, and out of school hours and during his vacations he assisted his father in the labors of the shop. He began in the spring of 1827 seriously to learn the trade. A year later, however, he returned home to assist his father in constructing several tower clocks, these labors keeping him employed until he attained his majority in 1831. He then started a small shop of his own for the manufacture of machinists' small tools together with the building of lathes. Two years afterwards he again joined his father and formed the co-partnership. In 1850 he built a graduating machine and the firm commenced the manufacture of scales and rules. Among the inventions of Mr. J. R. Brown were the universal milling machine, a screw machine, the universal grinding machine, and the formed milling cutter, all of which are now in general use. Mr. Brown died at the Isle of Shoals, N. H., July 23, 1886.

JOHN E. SWEET was born in Pompey, N. Y., Oct. 21, 1832. He attended a common school from the age of 7 to 15 and in 1850 he was apprenticed to learning the carpenter and joiner's trade, and subsequently spent about two years in an architect's office, paying his own board and expenses for the privilege of being there. He later spent some ten years in the joint occupations of architect and builder. From 1862 to 1864 was spent in England and Europe as draftsman and designer. In the latter year he returned to Syracuse to assume the position of designer and draftsman for Sweet, Barnes & Co. This position he left in 1867 to exhibit at the Paris Exposition one of the first type-setting machines. On returning from the Exposition he took charge of the shops of the above company. From 1871 to 1873 he was engaged in bridge building in the vicinity of Syracuse, and from 1873 to 1879 was spent at Cornell University. The Straight Line Engine Co. was organized in 1880, and since that date he has been president and manager. He was one of the founders and an early president of the American Society of Mechanical Engineers, a judge at the World's Fair, and is now president of the Engine Builders' Association of the United States. Elsewhere in this issue we have devoted some space to the machines and shop with which his name is identified, and these exhibit the impress of his wide technical knowledge. His inventions cover a broad range and the character of his work is keenly appreciated among mechanics here and abroad.

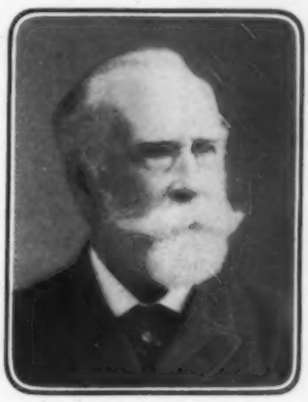
AMBROSE SWASEY is a native of New England and was born in Exeter, N. H. He received his educational training in the district school and at 18 entered upon the machinist's trade. In 1870, in company with his present partner, Mr. Worcester R. Warner, he entered the employ of the Pratt & Whitney Co., at Hartford, Conn., and while in charge of their gear department invented and perfected the epicycloidal milling machine for the production of the true theoretical teeth of gears. Mr. Swasey subsequently invented a new process for generating and cutting the teeth of spur gears and exhibited at the World's Fair an automatic gear cutting machine embodying the principles of the invention. In 1880 he resigned his position with the Pratt & Whitney Co. and with Mr. Warner established the Warner & Swasey Co. in Cleveland. Mr. Swasey's ability as a mechanical engineer combined with Mr. Warner's taste for astronomical pursuits led the firm to take hold of the manufacture of the mathematical instruments

natural and special adaptation of what may fitly be termed a universal machine tool. Either of these is essentially a compromise because the special machine is more limited in its working range; on the other hand the "universal" type generally lacks efficiency. The bringing of tools already set to the requisite angle and distance was a vast saving in time over the machine tool demanding separate adjustment prior to every cutting operation. Thus the repetition of a series of operations may be continued throughout the manufacture of any article desired in quantities and this is, of course, a direct need where the product must not only be produced economically but is also to interchange with other pieces of the same kind. The objection to the turret machine has been the cost of the tools applicable to the requirements of the work. The gradual adoption of cast iron as a foundation for many of these and the greater availability of a number of the appliances has removed the force of this objection to a considerable extent. The machines have steadily grown in size and capacity from their early usefulness in the manufacture of sewing machine parts to the recent construction that handles large cone pulleys, or 2x24-inch spindles.

Two notable screw machines are here illustrated. One is the first automatic turret machine (the turret turning automatically with the backward motion of the slide), or screw milling machine, as it was then termed, that the writer was been able to locate, the other machine is the familiar flat turret lathe of more recent construction. The older machine was made by Robbins & Lawrence (now the Jones & Lamson Machine Co., Springfield, Vt.), at Windsor, Vt., and was probably designed by Mr. Fred W. Howe, an able designer connected with the company in its early history. This machine until recently has been running in the plant of the Cushman Chuck Co., at Hartford, Conn. Second only in importance to the invention of this machine was the work of Mr. R. D. Stone, who was connected with the firm in various capacities from some time in the fifties until the year 1888. The development of the machine during that period was the work of Mr. Stone. His first step was to place the automatic mechanism for rotating the turret under the turret head free from exposure to chips. Following this improvement was the application of the machine to larger work, which called for a power feed to the turret slide and clutch back-gears to the headstock. It is probable that with the exception of the important work of Mr. Parkhurst, of the Pratt & Whitney Co., in designing the Parkhurst wire feed, Mr. Stone was the leading designer of these important details. The improvements patented by Mr. James Hartness were put in use by the Jones & Lamson Co. in 1888, and in 1889 Mr. Hartness took charge of the shop as superintendent. After making a few changes in the original machine he designed the flat turret machine tool. This is illustrated and the comparison between the two machines tells its own story, making it unnecessary to dilate at length upon the differences in design. Probably the matter of lubrication, shown by the gravity system in the older machine, as compared with the forced supply provided in the later Jones & Lamson turret lathe, the anvil design, etc., will suggest other features of machine tool development in this and other lines.

Along the line of the turret machine has been developed a type of multiple action tools which have presented a num-

James Hartness.



Coleman Sellers.

Wilfred Lewis.

utilized in astronomy. The Lick telescope in California, the meridian circle and equatorial instruments at the Naval Observatory at Washington and the Yerkes telescope at Lake Geneva, Wis., are specimens of the skill placed at the service of the astronomer. Mr. Swasey is a past president of the Civil Engineers' Club of Cleveland, a charter member of the American Society of Mechanical Engineers and has had the title of Chevalier of the Legion of Honor conferred by the French Government.

THE WORK of Mr. James Hartness, president of the Jones & Lamson Machine Tool Co., has already been mentioned in connection with the turret machine and the following facts briefly outline his career: He was born in 1861 and commenced work at 16 in the Younglove, Massey Co.'s shop in Cleveland, near the present plant of the Warner & Swasey Co. He was afterwards employed in various Cleveland shops, including the Union Steel Screw Works and the Lake Erie Nut & Bolt Works. In 1881 he went East to take charge of a bolt shop in Winsted, Conn., and remained there about three and a half years. He then entered the employ of the Union Hardware Co., at Torrington, Conn., and was with this firm three and a half or four years more. After a few changes he joined forces with the Jones & Lamson Co. in the spring of 1899 and has since then been in charge successively as superintendent and president.

COLEMAN SELLERS was born in Philadelphia in 1827; was educated at private schools and at Bolmar's Academy, West Chester, Pa. He received the degree of doctor of engineering from Stevens Institute of Technology and was appointed professor of engineering practice there in 1886; he was given the degree of doctor of science by the University of Pennsylvania in 1899. Mr. Sellers is a past president of the American Society of Mechanical Engineers, the Franklin Institute, and the Pennsylvania Museum and School of Industrial Art; vice-president of the American Philosophical Society, a member of the American Society of Civil Engineers, American Society of Naval Architects, Institute of Civil Engineers, and the Institute of Mechanical Engineers, Great Britain, and is a Knight of the Royal Norwegian Order of St. Olaf. He is the chief engineer of the Niagara Falls Power Co. and the engineering work incidental to the development of the power of the Falls was done under his advice and direction.

WILFRED LEWIS was born in Philadelphia in 1854; graduated from the Institute of Technology, Mass., in 1875, with the degree of S. B. M. E., and at once entered the employ of Wm. Sellers & Co. After three years' service in the machine shop, acquiring practical experience in fitting and the operation of machine tools generally, he was successively draughtsman, experimenter, designer and assistant engineer. In the latter position he was actively interested and practically identified with the greater part of the work emanating from Wm. Sellers & Co.'s plant from 1886 to 1900, when he voluntarily resigned to assume the presidency of the Tabor Mfg. Co. Mr. Lewis has been for many years an active member of the Franklin Institute, the American Society of Mechanical Engineers and the Engineers' Club of Philadelphia. He was one of the founders of the last-named organization, gave considerable attention to its interests, and was elected president in 1892. The well known experiments on gearing and belting were conducted by him for Wm. Sellers & Co., and he prepared the reports which appeared in the transactions of the A. S. M. E. some sixteen years ago. Mr. Lewis is best known as an expert in matters pertaining to gearing, but his experience includes hydraulic and special machinery, a broad practical acquaintance with machine tools and more recently molding machines.

ber of cutters in simultaneous work on two or more pieces at the same time. A number of rods could be cut up into studs, for example, and a different operation performed on the end of each of the several rods at the same instant. A rod would be turned down by the one tool and then moved in front of the next tool for threading, the two operations going on at the one time on two rods. Some of these automatic machines evidence a truly remarkable degree of ingenuity and are deserving of a detailed mention far beyond the limits of the present article.

Perfecting of Shop Measurements.

The open side planer, the radial and multiple drill, the gear cutter and planer, the increase in capacity of portable tools by the introduction of electricity and compressed air, are but a few among the many agencies that have brought the modern machine shop to its present efficiency. The gradual adoption of standard reference gauges has been a necessary preliminary to the development of interchangeable parts and practice, and among these useful instruments for comparative purposes is the micrometer caliper. It has reduced the problem of shop measurements to a degree of facile certainty that previously rested upon a very uneven basis, and by this means has aided in the maintenance of a uniform workmanship unattainable in any other way. Lathes and other tools are now built with micrometer adjustments whereby the machinist may readily transfer the amount determined by the caliper to the tool and remove the surplus stock without any previous guesswork.

The advent of the blue print has had a strong influence; how great an effect is not easily measured. Perhaps the extent of its every-day use may suggest the character of the limitations imposed by its absence. By the ready and inexpensive duplication of the details worked out in the drafting department it has rendered void the old fear of the destruction of the original drawing if it was sent into the shop or of misunderstanding if reliance was placed upon oral directions. The blue print holds its own for general convenience and cheapness, despite the production of other papers. Less reliance is now placed upon the uncertain rays of the sun, and in many shops the exposure is made by the aid of an electric light. The camera is also an efficient ally in this department of design and reproduction.

The chalk age of the machine shop has ceased in these establishments that make an effort to stand upon a manufacturing basis. It may still be found elsewhere in the production of rough sketches upon a too convenient bench or floor, or as a means of laying out a number of holes in a shaft or casting. The template, even if it consist of a strip of sheet metal with perforations corresponding to the location of the desired holes and a center punch, serves a useful purpose where the work is of a character permitting of no further elaboration. In the preparation of metal templates of sheet steel to serve as guides in the making of irregular cutters and similar work a high degree of handicraft has been lavished upon these aids to the workman. The jig has taken the place of these older expedients for manufacturing operations; it has enabled a workman to do as good work as the skilled machinist who made the jig and at a fraction of the time the work could otherwise be done. A jig not only sizes the drills passed through the openings in the bushings, but means are provided for the holding of the piece securely in position during the operation. This is of course in addition to the more obvious uses of the jig for drilling holes accurately in place.

Card Systems, Tool Room, Etc.

Among the many adjuncts to the furtherance of business must be mentioned two that are usually considered in reference to the office. These are the card system in its possibilities for exhibiting the cost, location and condition of every item of expense, and the methods in vogue for the encouragement of a lively co-operation between the employer and the employe. The time and cost accounting systems of representative shops have already had some attention in *The Iron Trade Review* and the subject is one of the utmost importance. The extension of the card system to cover the work done in repairs upon the tools used for manufacturing purposes and the indexing and changes of patterns, is an obvious continuation of their present purpose. On the back of these cards could be sketched rough outlines of the piece to show more clearly the alterations and thus preserve an intelligible record of its history. The color of the card would serve as an index to the material. The same thing is advisable in keeping track of the special tools that from time to time are made or purchased and speedily forgotten by the majority of those who may have had an opportunity to see them. The small tool that is infrequently used has every facility to be missing at a time when it is greatly needed, and the time spent on the search is just so much taken from the legitimate employment of the workman. The tool room will find this method or some variation of it a cure for the aching demand that will arise for something of the sort.

The modern tool room is in itself an effort along these lines—a clearing house for the exchange and care of the shop means of manufacturing, and the brass check currency will have further utility with the addition of the card system. The tool room itself has been a potent factor in the systematic management of shops. It started out in all probability with the assignment of some workman to the care of the tools that had hitherto moved uneasily about the shop from one workman to another, seldom in good repair and often lost to sight. The preservation of the tools and their maintenance in the most favorable condition for the production of a maximum quantity and quality of work led by an easy transition to the general growth and introduction of the system until the tool room has reached the point where its influence dominates the entire plant. The sets of tools for some particular purposes are now in many instances checked out in a lot sufficient for the task the machinist has before him and there is no need of gathering the tools together piecemeal. This plan has been extended to other departments, and in the erecting room and in the preliminary assembling of parts, the elements are assorted by what may be conveniently termed unskilled labor, and there is no time lost by the more expensive employe in the performance of duties demanding less ability than it is within his power to give.

Shop Conditions Keep Pace With Improved Tools.

The introduction of labor-saving machinery and methods has developed a regard for the shop surroundings. A highly developed machine tool is but an added convenience for the laborer and an extension of his natural forces. Good light, improved sanitary conditions, etc., are also aids to the fullest development of the latent physical forces. It would be absurd in the extreme to install a machine capable of fine adjustments under conditions where the light would not permit the workman to handle the tool to the amount of the advantage intended by the designer. All other shop adjuncts to the comfort of the employe are becoming better understood and recognized as factors toward an increased efficiency of the plant as a whole, and this belief will inevitably tend to eradicate the mistaken conception that the expense of shop betterment projects is necessarily filched from the amount due the employes as wages, or that the cost is borne by the employer from purely charitable and disinterested motives. It is along the line of that economy with which the employer furnishes sets of standard arbors, micrometer calipers and other gauges, etc., to the end that better work may be done with greater comfort. The employer may elaborate his plant to an inordinate extent from personal pride in the result of his labors or from sheer philanthropy, but these are not the usual commercial incentives to the building of well-lighted workshops and the general introduction of the best type of modern equipment.

Space is lacking for any comprehensive study of machine shop buildings, but reference may be made here to the works of the Straight Line Engine Co. at Syracuse, N. Y. This company manufactures the engine designed by Prof. John E. Sweet and the design of the building is as original and striking a departure as the other efforts of that gentleman in the field of mechanical engineering. The steam engine built by Prof. Sweet in 1872 was placed on the top of the building, as shown in the illustration, and beneath it is a bust of James Watt. There is no attempt at exterior decoration of any complicated form, the architectural effect resting upon a judicious grouping of the openings, and these are of the simplest form. The inscription over the door is suggestive

of the American spirit shown by the most enterprising firms, and this invitation to any and every one interested is only remarkable because of its publicity to the world at large and not because the custom there is an exception to the rule.

Intensified Production and its Remuneration.

Some mention may be made of the methods in which the remuneration of the workman has been adjusted in the several shops. The daily wage based upon the average rate common in that particular section of the country is a guide when the employe enters upon his labors, and his salary will naturally be fixed at some intermediate point between that average rate and the minimum paid in that shop. The introduction of piecework in place of the daily rate was made with the object of inducing the workman to increase the rate of production. The method operated successfully up to a certain point, but when the rate of increase had resulted in such gains to the employe that his former recompense seemed extremely low by comparison, then the piecework prices were liable to be cut down. This has been so commonly understood that the workmen in many cases would slacken their efforts as they found themselves approaching the dangerous limit and the interest in any future progress was stifled. Mr. F. A. Halsey of the *American Machinist* has worked out a variation of the piecework plan which has been applied in a number of shops here and abroad with considerable success. The premium plan, as it is generally known, is based upon a community of interest between the employer and the employe in the increase of output and the reduction of costs. The system depends upon a division of the profit obtained by a lessening of the time taken in the performance of any task. The workman receives at all times the minimum standard of remuneration calculated upon the average attainments of hourly labor plus a proportion of the value of the time saved. A detailed consideration of the premium plan and its application to the various branches of industry would be beyond the limits of this article, but it is one of the most interesting of the improvements that have been adopted by the progressive management of many modern machine shops and its influences will be carefully watched by the student.

The new plant of the Pittsburg Valve, Foundry & Construction Co., on Railroad street, between Twenty-fifth and Twenty-sixth streets, Pittsburg, is fast nearing completion and the plants of the company will be shortly centralized in the new buildings. The new plant will be one of the best and most modern in the country for pipe bending and pipe fitting work. The Globe Plow Works, formerly operated by Alex. Speer & Sons, has suspended operations. A new plant for the company is being erected at Carnegie, Pa., however, at a cost of $150,000.

The bulk of the order of the Pennsylvania Railroad Co. for the new steel cars has been placed with the Pressed Steel Car Co., of Pittsburg. The contract calls for 9,000 cars. This contract calls for 5,000 steel hopper cars of 50-ton capacity; there are also included 2,000 low-sided gondolas.

The new plant of the Pittsburg Coal Co., at Montour Junction, Pa., has been completed and is now in operation. Coal cars for railroad use, coal pit cars and mining machinery will be manufactured at this plant. The plant consists of five buildings.

The plate mills of the Homestead Steel Works of the Carnegie Steel Co., at Homestead, Pa., broke all records during the month of October. The 28, 30 and 42-inch mills made big showings. The 30-inch mill turned out 27,000 tons of slabs, and the 28-inch mill turned out 12,000 tons of finished plates. The 42-inch mill broke all records by turning out 9,000 tons of universal plates. The Bessemer department broke all previous records by 1,400 tons.

The Ohio Galvanizing and Machine Co., Niles O., last week awarded contracts for the erection of its new plant. The main building will be 50x200 feet.

RITER-CONLEY MANUFACTURING CO.

As builders of blast furnace plants, the Riter-Conley Manufacturing Co., of Pittsburg, is known to the iron masters of the United States as well as Canada and England. Nearly all the modern blast furnace plants of this country have had work done upon them by this concern and the largest foreign plant of their erection is that of the Dominion Iron & Steel Co., of Sydney, Nova Scotia, their contract including not only the blast furnaces but all the steel buildings as well. Other blast furnace plants recently completed on which a large portion of the work was done by this company are the Eliza plant of Jones & Laughlins, Ltd., of Pittsburg, and the plant of the Sharon Steel Co., South Sharon, Pa. Several furnaces of the Carrie group of the Carnegie Steel Co., at Rankin, Pa., were also recently completed by this concern.

The company was organized by Messrs. Riter and Conley in 1873. In 1899, the year following the death of Mr. Conley, the company was incorporated and officers were elected as follows: Thomas B. Riter, president; William C. Coffin, vice-president; John S. Craig, secretary and treasurer; Robert A. McKean, general manager.

The company has two plants, one in Allegheny and the other in Pittsburg. The former is the most modern and

Thomas B. Riter.

John S. Craig.

covers seven acres of ground. The output of these plants consists of boilers, tanks, riveted containers, pressure holders, steel works and foundry ladles, and supplies for blast furnaces, steel works and grain elevators. Recently a contract was awarded the company by the Crucible Steel Co. of America, for the erection of three blast furnaces at Clairton, Pa. Another line of work that engages the attention of the company is the erection of oil tanks, nearly all of the tankage constructed in the recently discovered Texas oil field having been done by it. The company also designs and erects steel buildings, roof frames and trusses and does all kinds of heavy plate work. Owing to the erection of a new office building adjoining its Water street plant, Pittsburg, temporary headquarters have been established at 443 Liberty street. The new office building will be 160x48 feet and will be modern in construction.

The spike and merchant steel plant of Dilworth, Porter & Co., located on the South Side, Pittsburg, was almost completely destroyed by fire last week, entailing a loss of about $250,000. The 18-inch, 16-inch and 10-inch mill departments were completely destroyed, while the other departments were completely gutted. As soon as the insurance matters can be adjusted the plant will be rebuilt. The plant contained 64 heating furnaces, 12 trains of rolls, and 30 automatic and 21 hand spike machines.

Williams Brothers, Minneapolis, Minn., have purchased a site of about six acres in Minneapolis upon which a large boiler and structural plant will be erected. The buildings of the plant will cost about $40,000, while about $50,000 worth of machinery will be installed.

The Crane Co., Chicago, has received a contract from the Russian Government for $20,000 worth of pipe for use in government mines in Siberia.

THE NEW EDGECOMBE CHAIN HAMMER.

We give illustrations herewith showing front, back and sectional views of a new patent chain hammer, which is manufactured by the Turner, Vaughn & Taylor Co., of Cuyahoga Falls, O. This company has been manufacturing chain machinery since the inception of the industry. The first hammers made were of the old Standish type. The one illustrated

Fig. 1.—Front View.

below represents the latest development in chain welding hammers.

In the operation of welding chain it is necessary first to strike a heavy blow to force the weld together, and then to strike a few light blows which shape the link and bring it into proper outline so that the link at the weld will be as good form as is the body of the link. It is also evident that to produce the best results from a given amount of energy it is necessary that it should not be retarded. With the old style hammer the energy which was imparted to the hammer through the medium of the treadle was naturally neutralized a certain amount by the action of the spring which returns the hammer bar to its proper position. In this new hammer this has been overcome by connecting the

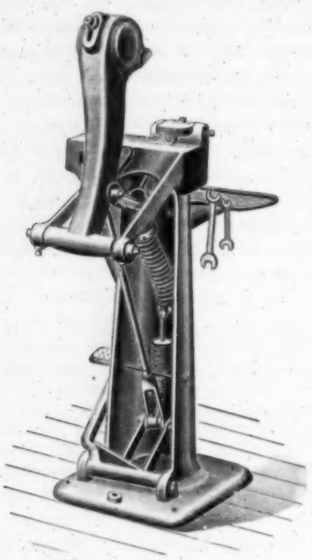


Fig. 2.—Rear View.

main spring of the hammer to a toggle joint in such a way that the effect of the spring upon the hammer head is the greatest when the head is in its upper position. As soon as the hammer commences to move forward the action of the toggle is such as to cause the spring to have no effect upon the hammer bar, with the result that all the energy which is imparted to the hammer by the foot treadle is utilized in the blow of the hammer head.

Another feature of importance is an arrangement whereby the action of the main spring can be made light or heavy, and consequently adjusted to the work which is being performed. The light shaping blows referred to have never been provided for in any hammer previously placed on the market. This action is brought about on this hammer by the use of a supplemental spring known as a cushion spring and which will be noticed in the cut near the base of the column. This comes into action when the hammer has nearly reached its lowest position with the result that the light shaping blows which are desired can be very readily struck. Careful attention has been paid to minor details and the attachment of the dies has been simplified, avoiding the use of wedge and liners, as with the old style hammer, and giving to the upper die a universal adjustment which enables dies which are worn or slightly out of true to be brought into perfect alignment.

The working parts are enclosed so as to be free from dust and scale. The parts are all interchangeable and can

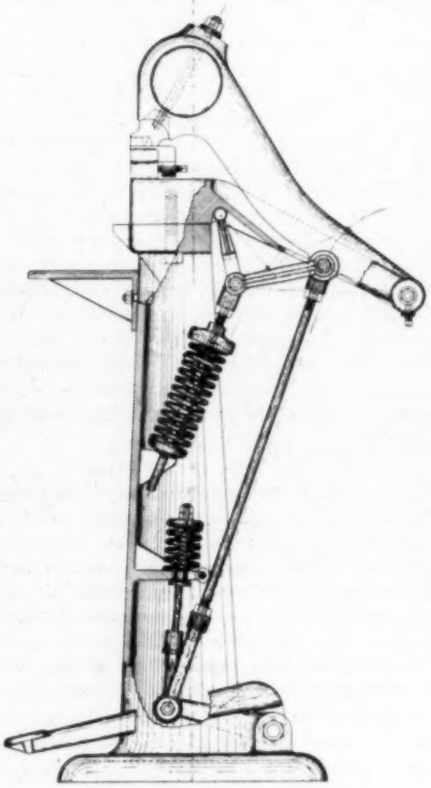


Fig. 3.—Elevation, Partly in Section.

be duplicated at any time, the principal bearings being made so that removal of parts when worn can be accomplished with light expense and little work.

Simpson Brothers of Pittsburg, manufacturers of gas ranges, have decided to locate a plant at Canonsburg, Pa. A site has been donated and $15,000 worth of stock in the company has been subscribed for by the citizens of the town. The plant of the company is now located on Twenty-sixth street, Pittsburg.

Tate, Jones & Co., with offices in the Empire building, Pittsburg, have recently closed several important contracts for elevating and conveying machinery. One calls for the erection of a conveyor for the Davis Coal & Coke Co., at Thomas, W. Va., to be used in taking coal from the mouth of the mine to the tipple. Another contract has been closed with the National Malleable Casting Co. of Sharon, Pa., for a conveyor to carry coal from the cars to the furnaces and gas producers. The work on the conveyor for the Pennsylvania department of the National Tube Co. is almost completed. The company is at present erecting its own plan at Leetsdale, Pa. The machine shop will be 60x100 feet. The other buildings will be added in the spring.

THE BRIQUETTING PROCESS FOR CORNWALL ORES.

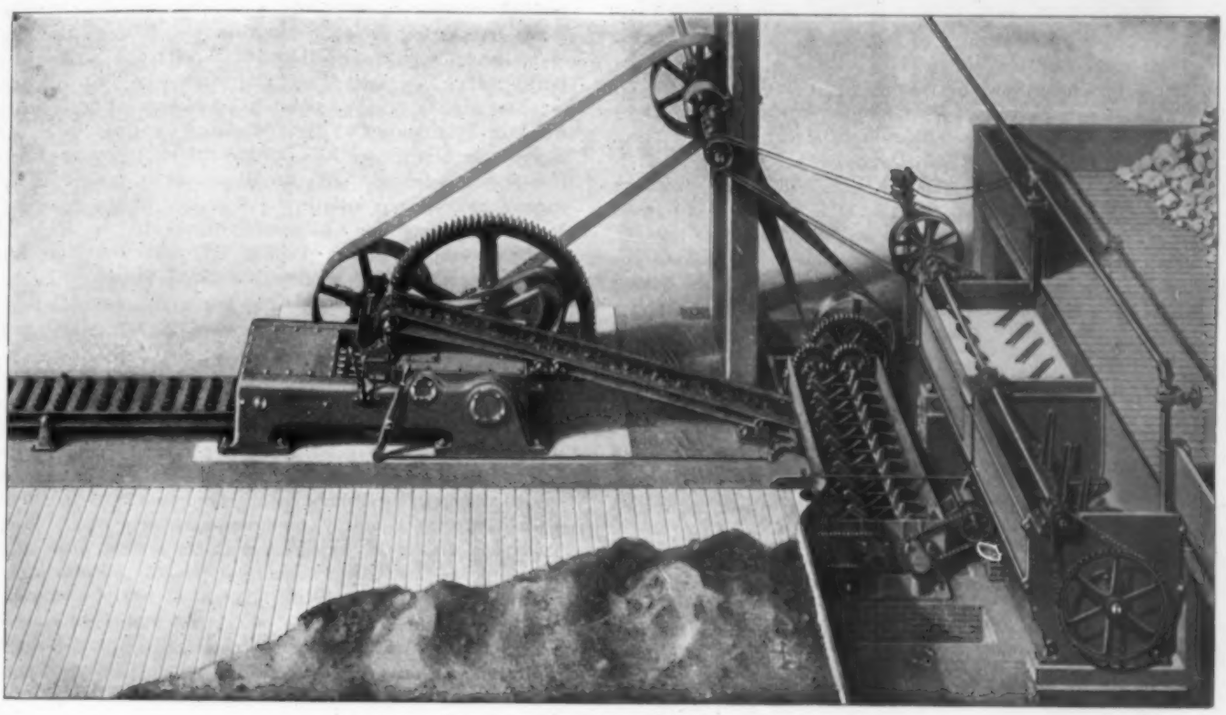
A departure in the methods of utilizing low grade iron ores gives promise that in the near future ores with a small percentage of iron will be handled to better advantage than at present. Experiments have been going on for a considerable time with indications of success. The work has been conducted by the Henry D. Mould Co. of Pittsburg, Pa., and at present they are erecting an experimental plant for the Pennsylvania Steel Co. at Steelton, Pa. It will contain one White briquetting press and outfit and the capacity will be 240 tons of ore a day. If success attends the experiment the Pennsylvania Steel Co. will begin at once the erection of a plant with a capacity of several thousand tons a day. It will probably be located at the mines.

The experimental station is being built for the purpose of working magnetic iron concentrates. The ore to be handled is from the Cornwall ore banks near Lebanon, Pa. Much of this ore, in its natural condition, is not sufficiently rich to justify smelting, containing only about 38 per cent of iron. In the new process the ore will be crushed fine and magnetic separation will follow. The resultant is an ore containing about 69 per cent of iron. Here the White briquetting machine will be brought into play and the ore pressed into solid bricks ready for the smelter. The binder used is slacked lime.

In the process developed by the Henry S. Mould Co., the lime slackers are fed from a platform, using first one and then the other slacker, so that while the lime is being slacked in one, the pump will be drawing from the other in which the lime has been slacked. Both lime slackers communicate by large openings at the bottom of a hollow middle casting. A cut-off gate is arranged from each of the openings to be operated from above. The openings are screened to prevent lumps from getting into the pump. The slackers are each driven independently by tight and loose pulleys. Either may be stopped or started independently of the other. The lime pump is driven by a chain from one of the mixer shafts. The stroke is regulated by a rod and hand wheel mounted on the dust feed, whereby the amount of lime may be accurately adjusted as desired.

The automatic dust feed is arranged as shown, the materials to be briquetted being fed into it through an opening in the dust floor. The top of the floor will be 2 feet 9½ inches above the general floor line. The dust feed is automatically regulated by a rod and hand wheel, both hand wheels being conveniently located for quick adjustment. The dust feed is driven by chain from one of the mixer shafts. The double mixer is provided with a friction clutch pulley, driven by a pulley on the line shaft. It is heavily geared. The clutch pulley is operated by a train of levers and rods from a hand lever on the side of the press. The feed belt from the mixer to the press is driven by a pulley on the pulley shaft of the mixer. It is supported by four rollers. The press is provided with a friction clutch pulley driven from a pulley on the line shaft, the clutch being operated by a handle on the side of the press.

The operator standing at the hopper of the press has control of all the machinery from that point. By stopping the mixer, he stops the feed belt, dust feed, and lime pump. From this point he has also in full view the lime slackers, lime pump, and the flow of lime; also of the dust feed and the stream of dust from it, of the mixer throughout its length, of the feed belt from the point at which it receives the mixed material to the hopper of the press, and also of the delivery belt. From this point he also directs the men who feed the dust and lime. The foundation around the dust feed provides for steps and a passage way under the corner of the dust floor, giving full head room under it and affording convenient access to the dust feed and lime pump mechanism and to the end of the mixer. The two posts supporting the line shaft are at the left of the feed belt, leaving the mixer free of access from all sides.



White Briquetting Press and Outfit. Capacity, 100 Tons Each in 10 Hours.

The first effort made in this country to briquette iron flue dust was in 1896 when the White mineral press was built at the works of the Carrie Furnace Co. at Rankin Station, Pa. The effort was crude, not sufficient pressure was exerted by the press to form solid blocks, and no attempt was made to dry the briquettes, these being dumped green into the furnace. Even under these conditions it was demonstrated that the process was profitable, and until the Carnegie Steel Co. purchased the works and dismantled it, the plant was kept in operation.

The Illinois Steel Co. at the South Chicago Works put in one of the same type of presses, and also installed an artificial dryer. They have used this apparatus to briquette their flue dust up to the present time, with the exception of a short period when the location of the plant was changed to allow an addition to the furnace plant. Though magnetic irons and ores concentrated for blast furnace use are now employed only to a limited extent, it is claimed that when briquetted they might form the sole ore charge in a furnace.

WESTERN MACHINERY MARKET.

CHICAGO, Nov. 11.—Optimism is the keynote of all reports from machinery manufacturers and dealers as to the outlook of the trade for the coming year. There are few concerns in this territory from whom we have heard, that do not report they have orders on their books sufficient to keep their plants busy in all departments for the next three to six months, should another order not be taken. With this very promising outlook, manufacturers who have had in view for some time extensive improvements and additions to their shops, feel little hesitancy in putting these plans into effect, and many report that with the opening of spring ground will be broken for new buildings and other changes inaugurated. All the machinery houses on Canal street report an excellent trade.

Stover Engine Works, Freeport, Ill., have orders for the Stover engine which will keep the plant running at its fullest capacity for the next three months. The company has recently added some special machinery for the manufacture of this engine, which increases the output of the plant.

H. W. Caldwell & Son Co., Seventeenth and Western avenue, Chicago, manufacturers of conveying, elevating and power transmitting machinery, report that they are perfectly satisfied with the present condition of business and the outlook. They are adding a four-story warehouse, 70x160 feet, to their present plant, which will be used for the manufacture of sheet metal specialties.

The Winslow Brothers Elevator Co., Chicago, has changed its name to the Winslow Elevator & Machine Co., and will have its main office and works at 100 North Clinton street.

The Dillon-Griswold Wire Co., Sterling, Ill., is installing four improved machines for the manufacture of Griswold wire fencing. These machines will produce two rolls of fencing at the same time. The company is also making improvements in the drawing room, and increasing the baking capacity; also adding six machines of a new style to its bale tie department. These improvements will give a largely increased output.

The Cleveland Twist Drill Co., Cleveland, O., has opened an office at 17 South Canal street, Chicago, which is in charge of John G. Ladrick.

The New Castle Bridge Co., New Castle, Ind., will build a plant at Indianapolis, consisting of main work shop, 90x300 feet; template shop, machine shop, boiler room, tool shop and office.

The Marinette Iron Works, Marinette, Wis., received an order several days ago for a gas engine to be shipped to the Isle of Pines, Cuba.

The Damascus Brake Beam Co., Washington avenue and Second street, St. Louis, Mo., will erect a plant in East St. Louis for the manufacture of their beams.

The Chicago office of the A. Leschen & Sons Rope Co., St. Louis, Mo., has been moved from South Canal street to 137 Lake street, where they will carry a complete stock of wire rope, manila rope, sisal rope, packing, waste, pulley blocks, sheaves, wire fittings, and various other kinds of supplies.

Henry E. Pridmore, 21st Street and Rockwell, Chicago, manufacturer of molding machinery, has recently received an order from the General Electric Co., Schenectady, N. Y., for two sets of the largest molding machines built at his shops. These machines are for special work, and the requirements have suggested several entirely original devices which will be employed in their construction. Mr. Pridmore is increasing the capacity of his plant by the addition of a two-story building, 60 x 100 feet, to be divided into a machine shop, drafting department and wood pattern shop; also a two-story building, 25 x 60 feet, to be used exclusively as an office. He reports that business is better than it has been for over a year, and that he is receiving many orders from agricultural implement manufacturers.

Among the contracts recently awarded to the Fred W. Wolf Co., 139 Rees Street, Chicago, manufacturer of refrigerating machinery, were the following: Ruehl Brothers Brewing Co., Chicago, 100-ton refrigerating plant, consisting of two 50-ton machines, together with direct expansion piping and complete brewery equipment for new modern brewery; Stephenville Ice Co., Stephenville, Tex., 10-ton ice-making plant complete; Cameron Ice and Cold Storage Co., Cameron, Tex., 65-ton refrigerating plant, complete with 20-ton ice-making plant; Chattanooga Brewing Co., Chattanooga, Tenn., ammonia condensers; J. C. Bertsch, Atlanta, Ga., equipment for ice-making plant for Lake City, Fla.; Philip Zorn Brewing Co., Michigan City, Ind., direct expansion piping for brewery; Stoll Brewing Co., Troy, N. Y., direct-expansion piping for brewery.

Barnard & Leas Mfg. Co., Moline, Ill., manufacturer of magnetic separators, has received a second order from the Griffin Wheel Co., Chicago, for a magnetic separator of four times the capacity of the first machine installed; also an order for one machine from J. W. Jackman & Co., London, Eng. The company reports that inquiries from both home and abroad are numerous, and that they are extremely busy in all departments of their plant.

The Maywood Foundry & Machine Co., Chamber of Commerce, Chicago, report the business outlook very satisfactory and that their order books are full. Among the contracts recently received were the following: Sterlingworth Railway Supply Co., Easton, Pa., a second order of four sets of molding machines; P. H. McArdle, New Orleans, La., one set of molding machines; Lorain Steel Co., Johnstown, Pa.; six machines for making cores; Weller Mfg. Co., Chicago, two sets of molding machines; Northwestern Foundry & Supply Co., Detroit, Mich., one set of molding machines. The company are now placing on the market a heavy type of gas engine, which will be known as the "Maywood" engine. It is designed especially for work in isolated electrical lighting plants, though it is adaptable for other power plants, three of these engines having been installed in the plant of the American Malleable Casting Co., Chicago Highlands, Ill.

The Davenport Spring Vehicle Co., Davenport, Ia., has been incorporated with a capital stock of $50,000. The incorporators are Isaac Klein, Finis Cartwright and Albert E. Cartwright. The company will build a new plant next spring.

Berlin Machine Works, Beloit, Wis., manufacturers of special wood-working machinery report that their output this year is by far the largest in the history of the company, and that the indications are for a still larger business during the coming year. For the past several months, export business has been improving from existing conditions, and in all its departments the company continues extremely busy. Plans have been drawn for an addition to its present plant of a one-story building, 200 feet square, of saw-tooth construction, which provides for a generous amount of light in all parts. A large electric crane will be put in and numerous machine tools. All the machinery in the new addition will be electrically driven, the power plant which the company put in two years ago being ample for this purpose.

The Charter Gas Engine Co., Sterling, Ill., builder of gas and gasoline engines, reports that there is nothing to indicate a let up in the excellent business it has had for months past. The company is shipping a carload of engines to Texas this week, and machines have been sent to all parts of the country, from the Atlantic to the Pacific coast, and from the Gulf to the British possessions within the past several weeks. An additional building will be erected next spring.

All conditions of general and special trade have worked together to make this the largest year in the history of the Bignall & Keeler Mfg. Co., Edwardsville, Ill., manufacturer of pipe threading and cutting machines, both as to the number and value of the machines built and shipped. The company reports that its general business has been greatly augmented by orders received for the complete equipments of new tube mills in the east, among which are mentioned Spang, Chalfant & Co., Etna, Pa.; the Carnegie Tube Co., Carnegie, Pa.; Alabama Tube & Iron Co., Helena, Ala.; also additions to the mill of the Mark Mfg. Co., Evanston, Ill. The order from Spang, Chalfant & Co. is of special interest, including ten independently motor driven machines to cut up to 16 inches. The discovery of oil near Beaumont, Tex., brought considerable business to this company, their orders from that vicinity amounting to two carloads. Other orders

still come in from that territory. In order to meet this increased demand for their tools, the company was obliged to increase the capacity of its plant during the summer by the addition of floor space and new machinery. At present the capacity is 50 per cent greater than it was last spring. To meet the growing demands for independently motor driven machines, the Bignall & Keeler Mfg. Co. has brought out a new line of these machines, superior in simplicity and general construction. They are prepared to furnish these machines in all sizes. They look for a greater business during the coming year, and their order books are full and all departments busy.

The Vilter Mfg. Co., Milwaukee, Wis., builders of Corliss engines and refrigerating machinery, reports that orders for this class of machinery have been very numerous of late, and that it finds it will be necessary to continue the plant in operation day and night for many months to come, as it has been doing for more than five years past. As previously reported in *The Iron Trade Review*, the company is building a new foundry, 110 x 280, a carpenter shop, for making flasks, etc., 44 x 144, and a new power house, 60 x 120. The foundry is to be equipped with two large electric cranes and the most mou ern tools and machinery.

John H. Dawson Machinery Co., 30 South Canal Street, Chicago, has secured the agency in Chicago for the Philadelphia Machine Tool Co., Philadelphia, Pa., and will carry a line of that company's punch presses, shearing machines, square shears, etc., in its rooms. The company has purchased quite a large variety of machine tools, in many cases complete shop equipments. Among the latter was the Reading, Pa., plant of the American Bicycle Co. It reports no diminution in the heavy demand for both second-hand and new machinery, which is for all kinds of tools.

The George A. Fuller Co. of New York has been awarded the contract for the erection of the Farmers' Deposit National Bank Building to be erected at the corner of Wood street and Fifth avenue, Pittsburg. The contract for structural steel erection has not yet been awarded. About 5,000 tons of material will be required.

The Solid Steel Casting Co., Chester, Pa., will shortly build an addition to its main building, increasing the latter to 300 feet in length.

The Henry Vogt Machine Co., Louisville, Ky., has recently purchased a site of 15 acres in the southern portion of the city, upon which will be located a large addition to their boiler plant. The company expects to expend about $200,000 in the erection of the new plant.

It is probable that the Tacoma Rolling Mills, Tacoma, Wash., will shortly commence the erection of an addition to its plant for the manufacture of nuts and bolts.

The capital stock of the Chicago Ornamental Iron Co. has been increased from $50,000 to $100,000.

The Inland Steel Co., Chicago Heights, Ill., is putting in additional equipment consisting of a 200-ton furnace, 1,000 h. p. engine and an extra train of finishing rolls.

The Keystone Driller Co., of Beaver Falls, Pa., has just completed the erection of two steel and stone buildings each 40x200 feet. The installation of machinery for the manufacture of portable drilling machines has also been completed and operations in the new buildings will commence shortly. A new brick office now under construction will be completed in December. The capital stock of the company was recently increased from $150,000 to $300,000 to provide for these improvements. The machines built by the company are used largely in testing iron ore bodies, gravel beds for gold, and are also used in the oil regions and for deep water drilling. The officers of the company are as follows: D. McAllister, president; R. M. Downie, treasurer, and R. G. Forbes, secretary.

HEYL & PATTERSON.

As engineers and contractors for elevating and conveying machinery, the firm of Heyl & Patterson, of Pittsburg, is well known not only to the iron trade but to the coal and other trades employing such machinery. The firm consists of E. W. Heyl and W. J. Patterson, both engineers who have made conveying problems a study with the result that they own many patents on machinery for this purpose. Machines for conveying billets, slabs, wire rods, bolts and other kinds of iron and steel material are in successful operation in the largest plants in the country having been built by this concern. One of the most notable of its installations is at the plant of the Sharon Steel Co., South Sharon, Pa. Machinery for the elevation and conveyance of coal is also one of the specialties of this concern, and a noteworthy plant has been installed at the plant of the Cambria Steel Co., Johnstown, Pa. Reciprocating conveyors for foundries are

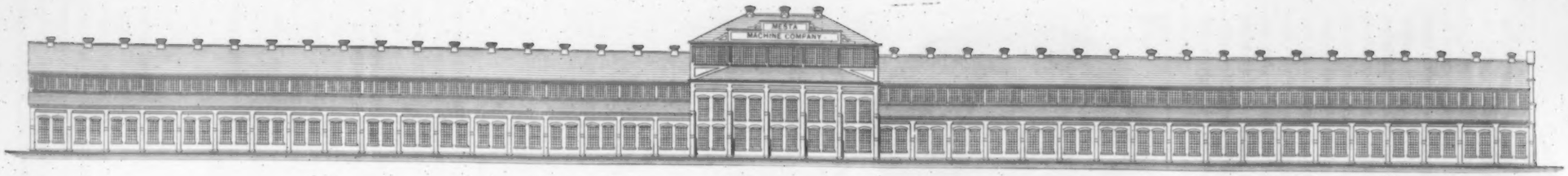
Edmund W. Heyl. W. J. Patterson.

also in increasing use, one of the largest installations of this kind having been made in the foundry of the Westinghouse Air Brake Co.

Upon the formation of the American Casting Machine Co. the pig casting machine controlled by Heyl & Patterson was acquired together with other types of these machines. Heyl & Patterson were appointed contractors and engineers for future work in this line and the equipment of blast furnaces with casting machines has proceeded rapidly since the formation of this combination. Until a short time ago the output of a plant located on Water street was sufficiently large to provide for the firm's work, but recently it has been necessary to erect an additional plant at Allegheny, Pa., which is already in operation. The offices of the company are on Water street, Pittsburg.

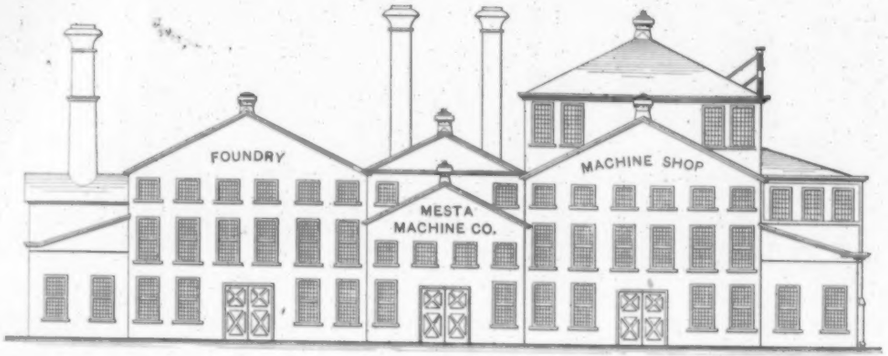
Carroll D. Wright, commissioner of labor, has in his report upon hand and machine labor submitted a comparison between the loading of 100 tons of soft iron ore upon cars in the year 1891 and the same operation performed in 1896. Under the hand method, by the use of the shovel and wheelbarrow, the work required 200 hours and an expenditure of $40; while with the aid of machinery, steam and hand shovels, the loading and trimming were accomplished in 1896 in 1 hour and 8.4 minutes. Adding to this the time assigned to tracklayers, the total time is 2 hours and 51.3 minutes—a ratio of 70 to 1 in favor of the later method. The comparative cost is given by Mr. Wright as $40 for the hand process and 55 cents for the other method.

The Manville Covering Co. of Milwaukee, Wis., has been awarded the contract for asbestos roofing matting for covering all the buildings of the new plant of the Allis-Chalmers Co., at Milwaukee, Wis. Orders have recently been received for one 1,500 h. p. vertical cross compound engine for shipment to London, England, three vertical cross compound engines for the Mohawk Valley Power Co., of 1,500 h. p. each and three similar engines for the Pittsburg & McKeesport Railway Co.



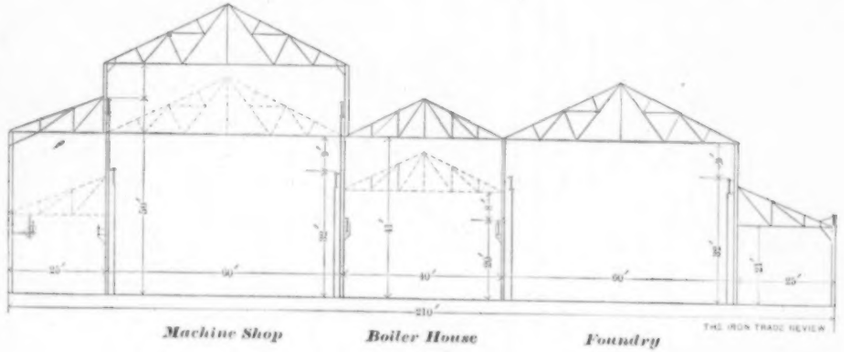
Side Elevation

Total length 820 ft.



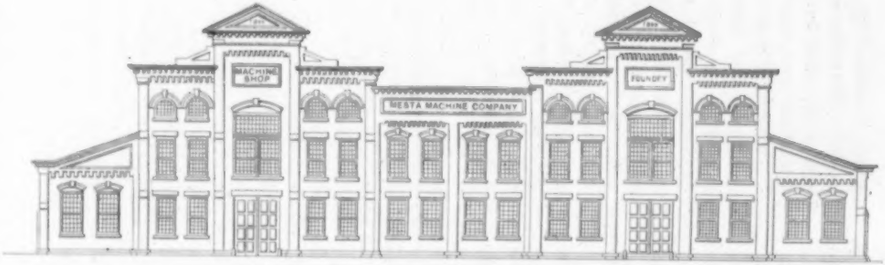
Rear Elevation

Front Elevation



Machine Shop *Boiler House* *Foundry*

Section



Front Elevation

Figs. 1–5.—Elevations of Machine Shop, Foundry and Office Buildings of the Mesta Machine Co.'s Plant, West Homestead, Pa.

The Mesta Machine Co.'s Works at West Homestead, Pa.

The Mesta Machine Co. of Pittsburg was chartered under the laws of Pennsylvania in November, 1898, and is a consolidation of the Robinson-Rea Mfg. Co., whose works were located on the South Side, Pittsburg, and the Leechburg Foundry & Machine Co., with works at Leechburg, Pa. The officers of the company are George Mesta, president; J. O. Horning, secretary; W. H. Rea, treasurer, and W. D. Rowan, auditor. The company began the erection of new works in November, 1898, on a ten-acre piece of ground located on the Monongahela river, about six miles above Pittsburg and one mile below Homestead. The property is situated between the Pennsylvania railroad and the Pittsburg, McKeesport & Youghiogheny railroad, and also has direct connection with the B. & O. railroad. The company also owns 200 ft. of river frontage which gives it direct connection with three leading railroads and the Monongahela river.

The buildings, which are 820 ft. long and 210 ft. wide, are entirely fire proof, being constructed of structural steel and fire brick. The frame work alone in the building contains over 2,000 tons of structural steel. The foundations for the heavy columns, which support the crane girders, are built of concrete and hard burned brick; the crane girders, columns and foundations being designed to carry cranes with 100 tons capacity.

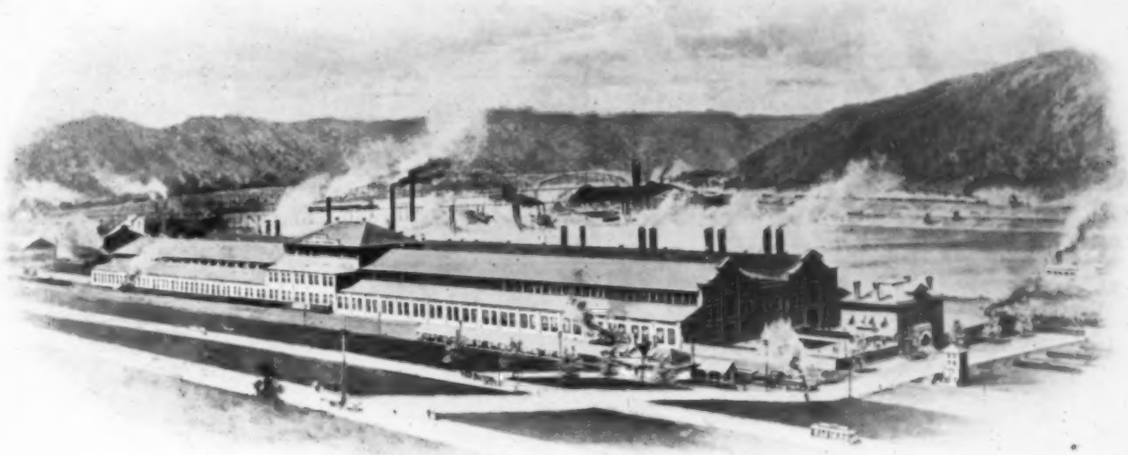


Fig. 6.—General View of Plant of Mesta Machine Co., West Homestead, Pa.

The plant has the largest output of rolling machinery of any individual rolling mill machinery plant in the world. Its roll department is first in output and it has the distinction of being the only roll foundry manufacturing sand, steel and chilled rolls. It is also unique in being the only plant in the country manufacturing machine molded steel gears.

When the works were built they were laid out with a view of incorporating a modern blowing engine erecting department; and being the last plant of this kind erected it has incorporated all late devices. At the present time it is the only plant in the Pittsburg district manufacturing Corliss blowing engines. One other concern for a time manufactured blowing engines, but today the Mesta Machine Co. is alone in the great Pittsburg district in supplying the demand for blowing engines in Allegheny county. Several years ago Andrew Carnegie stated that Allegheny county can equip an iron and steel plant with the one exception of blowing engines and he said that he hoped the day would come when such a plant would be erected in the Pittsburg district. Mr. Carnegie's desire is at last fulfilled.

The first order for blowing engines received was from the Illinois Steel Co. for five pairs, each pair weighing 420 tons. The specifications called for 44-inch high pressure, 84-inch low pressure, 84-inch air cylinder and 66-inch stroke. Four pairs of these engines have already been erected and are very successful.

The company manufactures all kinds of heavy rolling mill machinery, such as blooming mills, slabbing mills, bar mills, shears, roll lathes, etc., sand, chilled and steel rolls; machine molded gears made of steel or iron, steel castings; also Corliss engines, vertical blowing engines, horizontal engines and reversing engines.

Metal Yard.

The metal yard, as shown in Fig. 7, is 50 ft. wide by 820 ft. long, covered by a 15-ton overhead electric traveling crane. All material coming into this yard is weighed on a 100-ton track scale, and then unloaded by means of the crane. This crane is also used for charging the metal and heavy scrap into the furnaces. There is also located in about the center of the yard, the chemical and physical laboratory, where all raw materials are tested before they are used. Chemical and physical tests are also here made of each heat, both iron and steel.

Foundry Department.

The foundry department is comprised in a building 125 ft. wide by 820 ft. long, in which are nine overhead traveling cranes, ranging in capacity from 10 tons to 50 tons. The roll foundry occupies a space of 125 ft. wide by 180 ft. long, and contains two 15-ton air furnaces and two 18-ton air furnaces, in which all iron is melted for making rolls. These furnaces are charged by electric traveling crane direct from the metal yard, and are furnished with coal from one central coal storage, by means of electric overhead conveyor. This department contains a 10-ton electric crane over the molding floor and 30- and 50-ton cranes over the main floor. There are also several large casting pits, which permit of making the largest rolls used.

The green and dry sand foundry occupies a space of 210 ft. in width by 280 ft. in length, and contains two 30-ton air furnaces, one 72-inch cupola and one 84-inch cupola; also necessary drying ovens, core ovens, etc. This department contains overhead traveling cranes, ranging in capacity from 10 to 50 tons. All of the important castings, such as Corliss cylinders, engine bed plates, housings, etc., are cast from the air furnaces. The two 30-ton furnaces are so arranged that they can be tapped into one ladle. In this way they are able

to cast a 60-ton casting of air furnace iron. At the lower end of this department is a brick molding department where all cylinders and that class of work are cast. Just opposite this department is a large casting pit, which is of sufficient size to cast a Corliss cylinder 108 inches in diameter.

Gear Foundry.

The gear molding department is located between the iron foundry and steel foundry, thus permitting of filling the molds with either iron or steel, as may be required. This department contains three patent gear molding machines which are different from any other machines in use. On these machines the flask in which the mold is to be made is revolving on a table. There are two large housings which support a cross rail, and this cross rail supports a head which contains the pattern. By this method a gear with a large or small face, or with a large or small diameter can be made with equal accuracy. The gears and the dividing mechanism of these machines were made partly by the Gleason Tool Co. and partly by the Brown & Sharpe Mfg. Co. and gears made on these machines are claimed to be absolutely accurate.

Steel Foundry.

The steel foundry occupies a space of 125 ft. wide by 280 ft. in length, and contains four overhead electric traveling cranes, one 25-ton and one 30-ton acid open-hearth steel furnace. Also the necessary drying ovens, and annealing oven, which has sufficient capacity to anneal the largest sized casting. Natural gas is used for fuel in this furnace and castings as large as 50,000 pounds can be brought up to a bright cherry red, which is necessary to thoroughly anneal them. The company makes a specialty of high grade steel castings, such as engine shafts and cranks, housings, rolls, etc., and uses only low phosphorus and sulphur stock in its open-hearth furnace.

Fig. 7.—View of Stock Yard, Showing Facilities for Handling Raw Materials.

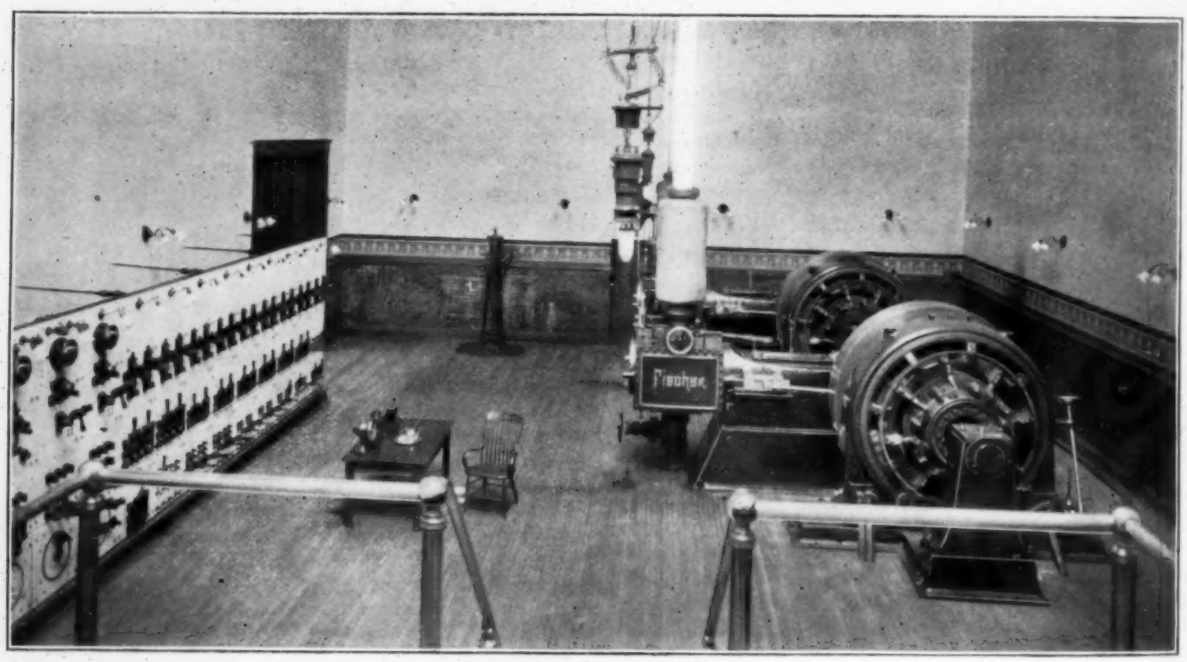


Fig. 8.—Portion of Electrical Power Plant.

Opening from the steel foundry is a building 40 ft. wide by 280 ft. long for cleaning the castings; also cold saws and other machinery for cutting off sink heads.

Machine Department.

The machine department is 85 ft. wide by 820 ft. long, and contains 9 traveling cranes ranging in capacity from 5 tons to 50 tons. It is divided into the following: Roll turning

department, which contains 15 roll lathes; machine tool department, which contains planers, slotters and shapers; a second machine tool department which contains all boring mills, lathes, drill presses, etc., and engine erecting floor, which has one traveling crane run-way 32 ft. to the rail, and one traveling crane run-way 50 ft. to the rail. The cranes on the 50-ft. rail are used for erecting vertical blowing engines. Engines are now being erected in this department which measure 47 ft. from the floor line to the top of cylinders. There is also a rolling mill erecting floor where all roll trains, shears, roll lathes, etc., are erected. Nearly all the tools in this department are driven either singly or in pairs by motors varying in horse-power from 5 to 40. The roll lathes are driven in pairs, while the larger tools have direct motors attached. The smaller tools are driven in groups by motors. This department also contains a large number of portable tools, which may be transferred from one portion of the department to the other by means of the overhead traveling cranes and are used extensively in working on large and heavy castings. The roll turning department contains 16 roll lathes driven in pairs by electric motors. Rolls varying in size from the smallest to the largest used can be turned, some of the larger rolls weighing as heavy as 15 tons. Connected with this department is a department for designing rolls for rolling the most difficult sections.

The tool room is located in the center of the machine department, and is two stories high. On the first floor all tools are stored and redressed by two Sellers tool grinders. On the second floor all tools are made. This floor contains lathes, shapers, gear cutters, grinding machines, etc.

The blacksmith shops are located in the building which adjoins the center portion of the machine department. It contains steam hammer, furnaces, forges, etc.

Power Plant.

The power plant is located in the center of the buildings and consists of two 300-h. p. Cahall boilers, two 300-h. p. engines (each being direct connected to a 200-k. w. Westinghouse generator); also a 150-h. p. Westinghouse gas engine and an 85-k w. Westinghouse generator. The current from all the generators is taken into one switchboard and from there the power is distributed to all parts of the shop by underground wires laid in conduits. All cranes and other machinery are driven by Westinghouse motors, the entire plant being operated by electric power.

The plant contains 20 overhead electric traveling cranes, ranging in capacity from 5 to 50 tons. These were designed by the Wellman-Seaver Engineering Co., of Cleveland, and all excepting two were built in the company's own shops. The cranes are built entirely of structural steel, and the castings, with few exceptions, are made of steel. Most of the cranes have now been used for over two years, and have given excellent service.

Heating System.

All departments with the exception of the foundry are heated by exhaust steam from the power plant. The system was installed by the B. F. Sturtevant Co., of Boston, Mass. Fresh air from the outside of the plant is passed over a series of pipes through which the exhaust steam circulates and the heated air is driven through galvanized pipes to the various departments by two 12-foot fans. In the machine shop and erecting department there are 82 outlets, sufficiently close to the ground to permit of the heating of the shop to 65 degrees in zero weather. The distributing pipes are carried along trusses of the lean-to of the building, thus keeping them out of the way of the traveling cranes.

Pattern Department.

The pattern department is located about 50 ft. from the upper end of the foundry department and consists of a building 50 ft. by 100 ft., two stories high, with wing 25 ft. by 50 ft., two stories high. The two floors in the main building are used for pattern making; the top floor of the wing which connects the foundry to the pattern shop is used for storing patterns which are ready for the foundry. There is also a platform in the foundry building upon which the patterns can be placed so that they can be reached with the traveling cranes. The first floor of the 25x50 ft. building is used for a carpenter shop.

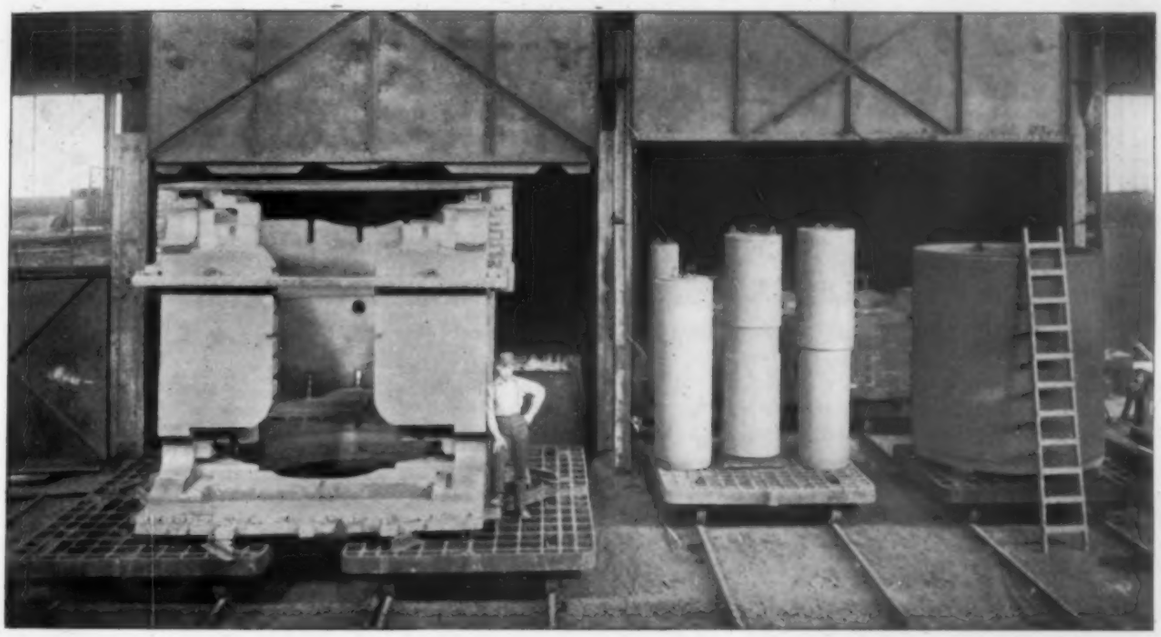


Fig. 9.—Drying Ovens, with View of Large Cores and Mold for an 84 x 66-inch Corliss Engine.

The office building is located about 50 ft. from the main buildings and is 45 ft. wide by 90 ft. long, three stories high, and is of strictly fireproof construction. The first floor contains time office, kitchen, dining room and reading room. The second floor contains the general offices. The third floor contains draughting room and engineers' offices.

Shipping Facilities and General Arrangement.

The shipping facilities are the best obtainable, the plant being located on four railroads and the Monongahela river. The general arrangement of the plant with reference to bringing material in and shipping the finished product differs materially from that in shops designed heretofore. Instead of the tracks entering the building parallel to the travel of the overhead traveling cranes, the plant is so arranged that three railroad tracks enter the shop at right angles to the travel of the cranes. This method has two advantages over others: First, the tracks take up much less room in running across the shop than throughout its entire length; second, the three

tracks divide the shop into four equal parts. Therefore the material is not carried any great distance to reach the tracks or the car. This arrangement divides the different classes of work in the shop into distinct sections. In the roll department, for example, all the raw material used in making the rolls is brought into one end of the stock yard. The roll molding and casting department is located in an adjoining building and the roll turning department also adjoins this. Thus the roll department can be operated almost as one individual plant, being divided by the railroad tracks from the other departments. This same arrangement is carried out in the other departments of the plant. To facilitate the shifting of cars in and out the company owns a small shifting locomotive. It is not only used in hauling material to and from the plant, but also in conveying castings from one portion of the shop to another.

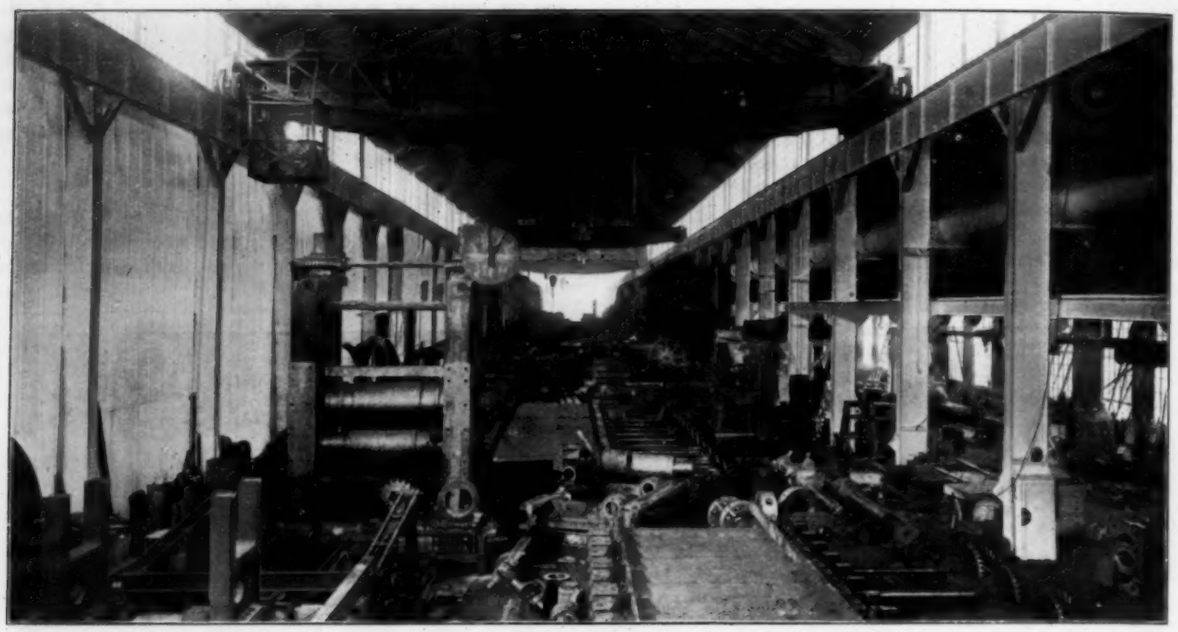


Fig. 10.—Lower End of Machine Shop, Rolling Mill Erecting Floor.

Fig. 11.—Interior of Foundry Building Just Before Completion.

The plant of the Eastern Tube Co., Zanesville, O., has been in partial operation for the past two months and is already furnishing certain sizes of tubing to the trade. We erroneously stated in our last issue that the plant would not be in operation until the first of the year. The management states that by that time it will be in position to furnish tubes from ⅛ to 16 inches in diameter.

The Chief Factor in Machine Shop Progress.

The general trend of industrial effort has been to supplement manual labor with purely mechanical appliances. The monotony of an oft-repeated task is best assumed by a machine. Naturally one would expect that a machine manufactory will exhibit the most impressive collection of machinery designed to produce a maximum effort with a minimum of skilled supervision. This expectation is fully realized, and in no other field of industrial effort has there been so steady a development of improvements as in the machine shop. Devices for the more economical use of time and material have kept pace with the design and introduction of automatic machinery. A prominent engineer of wide experience and liberal thought says in a recent letter to the writer:

"The whole question of the progress of the mechanic arts as influenced by the improvements in machine tools is one of great importance, and the difference between conditions in America and Europe in the use of such tools is worth serious consideration. In England, owing to the fact that the trades unions have such a hold upon the workmen, and to the strong antagonism between the working men and their employers, the utilization of the best automatic machines is

impossible. Several of these could be run by one man, but their trade regulations preclude the possibility of this manner of using automatic machinery. In other words, while with us five gear cutters may be run by one man, who makes very high wages, in England there must be one man to each machine, although the machines themselves require no attention except to shift the work, even though many hours may elapse between the starting of the machine and the completion of the job on hand. It will be a sad day for American workmen if the conditions that obtain in Europe become operative in this country. There is no incentive to the invention of labor-saving devices unless labor is saved by their introduction."

It is, however, a moot query as to what process or what machine among all the improvements of the past 30 or 40 years has been of most service in machine shop operations. *The Iron Trade Review* has invited an expression of opinion from a number of mechanical engineers and manufacturers. The replies are of varied interest and those selected for publication, as below, indicate the range of individual opinion.

The Emery Wheel Most Effective.

In reviewing the many processes, machines and improvements that have come into the machine shop during the past forty years to save labor, reduce cost and raise the quality of the product, it is not an easy matter to say which one surpasses all others. It is like trying to tell which is the best tree in a great forest. I deem the emery wheel to be the most effective appliance that has recently been introduced into the machine shop. The solid emery wheel is adapted to fitting and finishing with the utmost exactness the smallest parts of a watch, as well as the largest parts of massive machinery. It cuts with precision and rapidity, tempered steel or chilled iron; and when properly used the emery wheel of suitable grade will remove the amount of metal that is taken off by the finishing chip from shafts and cylinders of all diameters and lengths, at less cost and with greater accuracy than it is possible to do with the lathe followed by filing and polishing.

Metal cutting tools of all shapes may be sharpened to perfect edge and exact form, such as was absolutely unknown before the advent of the solid emery wheel. Recent improvements and experiments in grinding machines have demonstrated that even cast iron pulleys and other machine-parts may be made by the modern use of the emery wheel in specially designed grinding machines at less than one-half the usual cost, and superior quality may be secured without extra expense or special effort.

MILTON P. HIGGINS,
Norton Grinding Co.

Worcester, Mass.

Milling Machines and Milling Cutters.

Replying to your letter of inquiry, I should say that in the machine shop, pure and simple, the milling machine and the development of milling cutters and processes have done the most to change machine shop practice; but taking the working of metals, the punching and drawing presses if not first would be a close second. A great part of this work, not the milling machine itself, but the use of milling processes in the all-around shop has been largely introduced within the last ten years.

I prophesy that the next ten years will show if not such a change in method, certainly as great a change in machine tools, by making them do work rather than to suit the convenience of the operators.

Fig. 12.—View of Roll Turning Department.

Rigid machines, stronger driving power, and a greater range of speeds and feeds with better cutting tools will completely revolutionize the business.

JOHN E. SWEET,
President Straight Line Engine Co.

Syracuse, N. Y.

Milling Machine First, Grinding Machine Second.

We should think that the universal milling machine, designed by Joseph R. Brown and patented Feb. 21, 1865, from which design all the universal and most of the plain milling machines have sprung, is the machine that has made the greatest revolution in the machine shops in this country. The principles and general design of that machine have been copied not only in this country but throughout the industrial world.

The universal grinding machine, also designed by Joseph R. Brown and patented Feb. 27, 1877, we should think would come next; and the various turret machines and screw ma-

chines, both plain and automatic, designed by different parties, would take the next place. The introduction of the universal grinding machine made it possible to do work in hardened steel that could never be done before, and it was therefore instrumental in largely improving the quality of work in that direction.

R. VIALL,
Sup't Brown & Sharpe Mfg. Co.

Providence, R. I.

The Turret Machine and the Grinder.

In response to your letter asking for our opinion as to what process or machine among all the improvements of the past 30 or 40 years has been of most service in machine shop operation, I would say unreservedly, the turret machine and the grinder. The lathe and the planer were well known and of good construction 30 years ago. These, of course, have kept pace with the two machines named. When I say "the turret machine," that includes all classes of turret machines, and while the turret machine known as the screw machine has been of wonderful benefit, the turret machine for cast iron and heavy steel operations has been of just as great benefit to the business; and in addition to the increased output made possible by the turret machine, it has pointed out to the ancient lathe builder the possibilities of the engine lathe, and up-to-date manufacturers are keeping close up in improvements. A first-class article on the two classes of turret machines would perhaps give better reasons for the opinion expressed than anything I could say in this letter, as the subject is entirely too big to be handled within the short space we intend to give.

LODGE & SHIPLEY MACHINE TOOL CO.

Cincinnati, O.

Advancement in Milling Machines Leads.

The development of the improvements in the machine shop has been varied, and it is rather a difficult question to answer what machine has been the most serviceable in general machine shop work. It is our opinion, however, that the development of the milling machine has been such as to credit it as one of the leading machines in the machine shop, and more especially the vertical type of milling machine, which has taken the work from the planer at a reduction in cost of anywhere from 25 to 200 per cent, according to the nature of the work.

The slab milling machine has also had its field in taking the work from the planer at a reduction in cost of anywhere from 30 to 60 per cent. Of course, there have been automatic machines developed, which have been very useful in their special branch, but for general work, we think the advancement in milling machines has been greater than any other line.

BECKER-BRAINARD MILLING MACHINE CO.

Hyde Park, Mass.

Specialization in Machine Building a Great Feature.

I should say that the advancement in question should not be attributed to any particular type of machine tool, because jigs, templates and the special equipments for machine tools have contributed as largely to the result as the machine tools themselves. This is most evident in the modern shop which is devoted to one class of machinery. Here a special equipment is furnished for each detail of the product, regardless of whether the machining consists of turning, planing, milling or drilling.

While it is true that many machine tools are built for special purposes, it is also evident that the object sought by most of the makers is to have them adapted to a wide range of work. The modern shop system, handling conveniences, good machinery, and especially the concentration of the manufacturer towards building one class of machinery, are responsible for the vast improvement in the last 25 years.

E. A. MULLER.

Springfield, O.

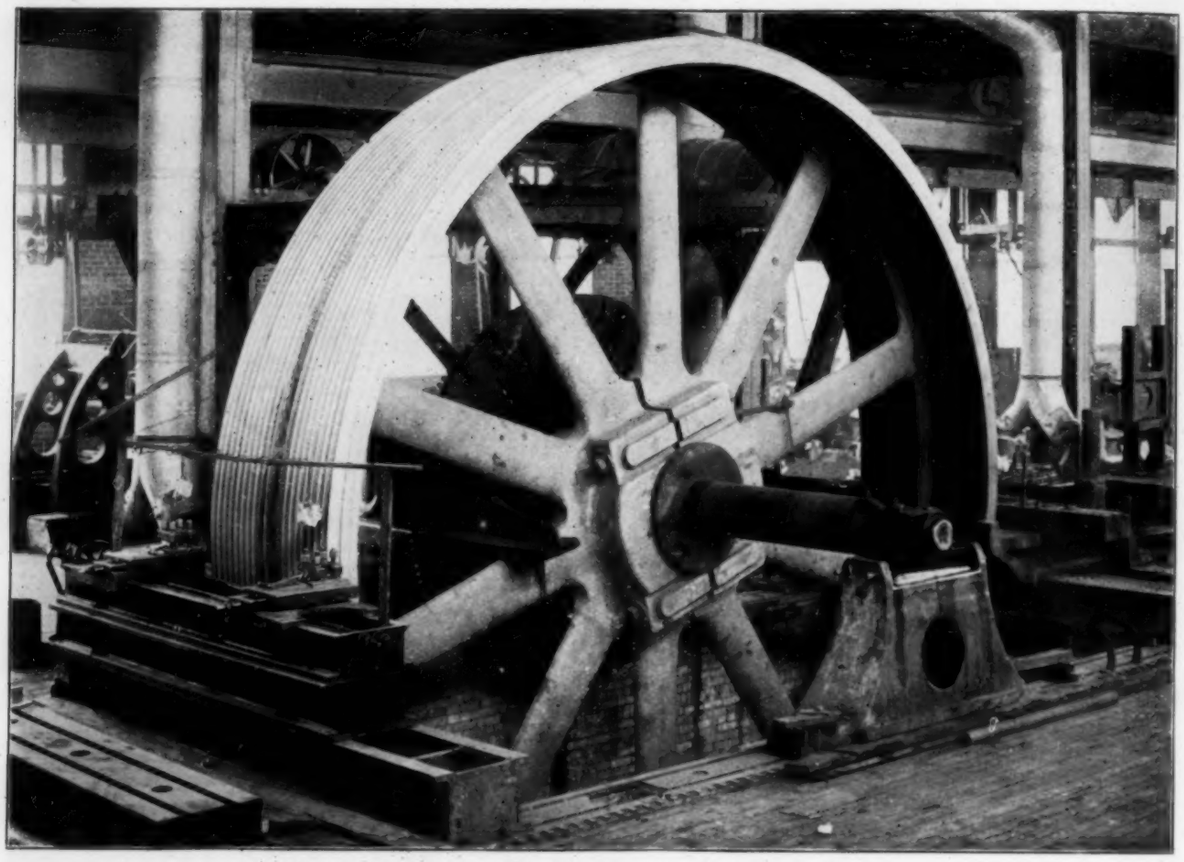


Fig. 13.—30-ft. Pit Lathe Turning Grooves in a 125-ton Rope Wheel.

Modesty Forbids an Answer.

Our time for several years has gone into the design and perfection of the gear planer, but modesty forbids us to tell you what machine we consider the crowning achievement of the 19th and 20th centuries.

GLEASON TOOL CO.

Rochester, N. Y.

The Turret Lathe.

The semi-automatic turret or monitor lathe has, in my opin-

ion, been the most marked and universally applied change of any in machine shop practice of all the great and numerous improvements that have taken place during the last 30 years. It is one of the greatest time savers for the production of many copies of the same machine part.

FORREST R. JONES,
Prof. Drawing and Machine Design Worcester Polytechnic Institute.
Worcester, Mass.

A Variety of Leading Causes.

In my opinion the great advancement made in machine shop work by way of increased output and the cheapening of product within the last 30 to 40 years has been accomplished largely through the following influences: The introduction of traveling cranes, key-seating machines, automatic gear cutters, automatic screw machines, turret lathes, milling machines, grinding machines, forming lathes, multiple drills, and various pneumatic tools for chipping, reaming and tapping, coupled with a more intelligent management in the office.

J. A. JEFFREY,
President Jeffrey Mfg. Co.
Columbus, O.

Unqualifiedly the Milling Machine.

In reply to your letter asking what process or what machine among all the improvements in the past 30 or 40 years has been of most service in machine shop operations, would say that we should unqualifiedly consider the milling machine to have most fully filled this condition as originally designed in its simpler forms and more fully in its later specialized types.

B. F. STURTEVANT CO.
By W. B. Snow.
Boston, Mass.

Milling and Grinding Processes.

There can be no doubt that the introduction of the milling and grinding processes have caused the most radical changes for betterment in machine shop practice during the last 30 or 40 years. Both deserve like credit. Though each may be applied independently, in many instances they are intimately dependent upon each other. Milling operations have made it possible to produce large quantities of duplicate, accurate work with little or no variation, and grinding machines have raised the standard of perfection to the highest practical degree.

S. H. STUPAKOFF,
Chairman Vulcan Mfg. Co., Ltd.
Pittsburg, Pa.

The Turret Lathe Most Revolutionary.

Replying to your letter, would state that, speaking for our particular line of manufacture, we believe that the invention of the turret lathe has been the greatest improvement in machine practice during the past 30 or 40 years. Of course, we are speaking only for ourselves, but the use of this tool has revolutionized manufacture in many other lines.

THE LUNKENHEIMER CO.
Sam L. Moyer, Secretary.
Cincinnati, O.

Fig. 14.—View of Foundry.

Automatic Screw Machines.

"What process or what machine of the past 30 or 40 years has been of the most service in machine shop operations?" Our judgment would be that the automatic screw machine has increased the output and has cheapened the cost to a greater extent than any other machine devised during the time specified.

THE CLEVELAND PNEUMATIC TOOL CO.
H. W. Cole, Secretary.
Cleveland, O.

The Automatic Turret Lathe.

In reply to your question, I should say that the introduction of the automatic turret lathe has been the most important

step in economical production in the past 30 or 40 years. My reason for this is that I believe this machine has brought about a greater increase of production per machine and per man, and a consequent greater cheapening in price than any other machine now in use in machine shops. The abandoning of small forgings for finished work and the greater use of the milling machine are two other important steps.

C. H. Benjamin,
Department of Mechanical Engineering,
Case School of Applied Science.
Cleveland, O.

Micrometers and Measuring Machines.

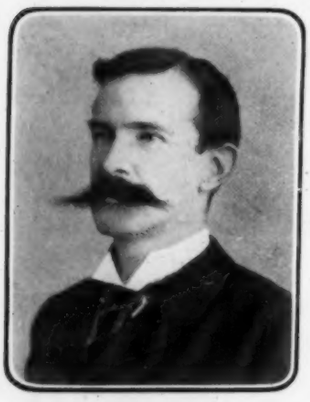
In reply to the question, "What process or machine among all the improvements of the past 30 or 40 years has been of the most service," I should say micrometers and measuring machines, for the following reasons:

The product from a tool cannot well be more perfect than the tool which produces it. Measuring machines, with their various offshoots, make it possible to manufacture perfect machines. This in turn (with the addition of skill in operating) makes more perfect work at a minimum cost, than would be possible without this indispensable tool. I am fully convinced that no one improvement, during the time mentioned, has had such a far reaching effect upon the development of the machine shop and the output therefrom as the micrometer.

W. L. Ely,
Brown Hoisting Machinery Co.
Cleveland, O.

A DISTINGUISHED STEEL METALLURGIST.

One of the most eminent authorities on the metallurgy of iron and steel, Mr. Howe is probably best known by his monumental work, "The Metallurgy of Steel." He was born in Boston, March 2, 1848, the son of Dr. Samuel G. and Julia Ward Howe. He graduated from Harvard in 1869 (A. M., 1872) and from the Massachusetts Institute of Technology in 1871. He was for a number of years a professor at the last named institution; since 1897 he has been professor of metallurgy at Columbia University. In 1893 Mr. Howe was president of the American Institute of Mining Engineers; in 1895 Bessemer medalist of the Iron and Steel Institute; in the same year gold medalist of Der Verein zwr Beförderung des Gewerbleisses. In 1895 also the Franklin Institute of Philadelphia awarded him the Elliott Cresson medal for distinguished scientific service. Mr. Howe was president of the jury of mines and mining at the World's Columbian Exposition.



Henry M. Howe.

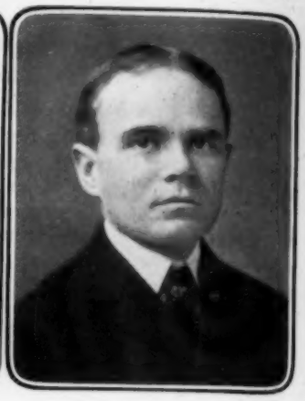
The Wharton Iron Co. last week decided to add a third furnace to its Wharton furnace plant at Port Oram, N. J. This will be known as furnace No. 3 and will be a duplicate of No. 2. Frank C. Roberts & Co., of Philadelphia, Pa., will be the designing and constructing engineers. The stack will be 100 feet high and will have a 21-foot bosh and 14-foot hearth. Sixteen tuyeres will furnish the blast. There will be four hot blast stoves. The power plant which now provides the power for furnace No. 2 will be increased in capacity by the addition of another pair of blowing engines. A Uehling pig casting machine will also be installed. Upon the completion of this furnace the furnace plant will have a capacity of about 1,500 tons per day.

All the chemical laboratories of the American Steel Hoop Co., located at Youngstown, O., and Pittsburg, have been discontinued. Hereafter all the work will be done either at the laboratories of the National Steel Co., at Youngstown, O., or at those of the Carnegie Steel Co., at Pittsburg.

FRANK C. ROBERTS & CO.

The members of the engineering firm of Frank C. Roberts & Co., of Philadelphia, are Frank C. Roberts, C. E., Ph. D., and John B. Miles, C. E. Mr. Roberts was born in New York City in 1861. He graduated from Princeton University in 1883 and was instructor there in civil engineering in the following year. He was engineer for the Trenton Iron Works of Cooper, Hewitt & Co. in 1884-86, and for Gordon, Strobel & Laureau, Ltd., of Philadelphia, from 1886 to 1888. In the latter year he opened an office in Philadelphia, and the business continued in his own name until 1893, when John B. Miles was taken into partnership. The construction and remodeling of blast furnaces has been a specialty with this firm, the following furnaces 100 ft. high having been built under their supervision: Lorain Steel Co., Lorain, O., 2; Lebanon Furnaces, Lebanon, Pa., 1; Warwick Iron & Steel Co., Pottstown, Pa., 1; Joseph Wharton, Port Oram, N. J., 1; National Tube Co., Wheeling, W. Va., 1; Jones and Laughlins, Ltd., Pittsburg, 4. They built the charcoal furnaces of the Cleveland-Cliffs Iron Co., Gladstone, Mich., and Antrim Iron Co., Mancelona, Mich., and are now building the new Pioneer Iron Co. plant at Marquette, Mich., which will probably be the most complete charcoal furnace plant in the world. The structural part of the business is of considerable magnitude, involving an average of 100,000 tons of material a year. An architectural department was added three years ago, with which Edgar V. Seeler is connected. The firm have paid considerable attention to ore roasting, having built a large plant for Joseph Wharton at Port Oram, N. J., and one for the Lebanon Furnaces at Lebanon, Pa., designed to roast fine ore and fired with furnace gas. F. C. Roberts is the patentee of the Roberts fire brick for use in the checker work of hot blast furnaces. Mr. Roberts is now in England, having been engaged by several large companies to report and advise on the reconstruction of their works on American lines.

Frank C. Roberts.

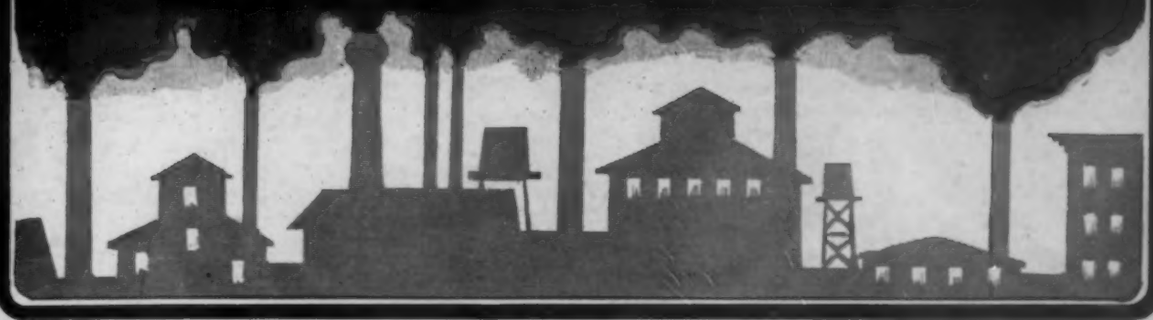


John B. Miles.

John B. Miles graduated from Princeton University in 1885 at 22 with the degree of civil engineer. He was employed by the Pennsylvania Railroad in surveys and construction work in 1885-6 and from 1886 to 1889 was assistant to the engineer of bridges of the Pennsylvania Railroad. He became connected with F. C. Roberts & Co. in 1889, being first in charge of the construction of the Monongahela Furnaces at McKeesport, Pa., and for several years was in charge of outside construction of furnaces, mills, pipe foundries, etc.

Furnaces Nos. 1, 2 and 3 of the Eliza plant of Jones & Laughlins, Ltd., Pittsburg, Pa., had record breaking runs during the month of October. Furnace No. 1 had an output of 15,045 tons of iron, No. 2, 16,038, and No. 3, 15,701. Furnace No. 4 was out part of the time and its record is not given for that reason. The output of the entire plant was about 55,000 tons for the month. This plant was fully described in Oct. 31 issue of *The Iron Trade Review*. Eugene L. Messler is superintendent. This output is considered particularly good by blast furnace managers, owing to the fact that a large percentage of Mesabi ore is used in charging these furnaces, often running as high as 45 per cent.

A CATALOGUE OF MECHANICAL EQUIPMENT AND SUPPLIES



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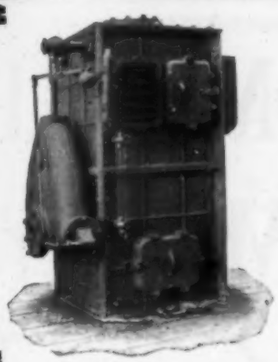

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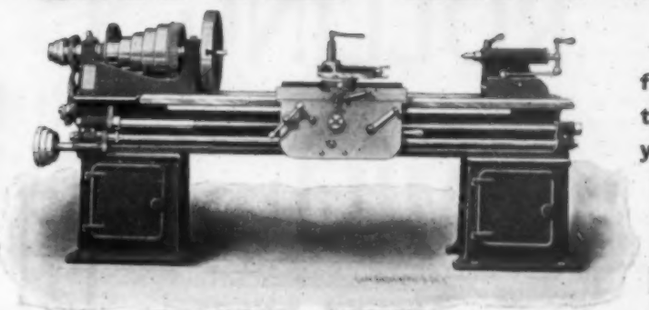

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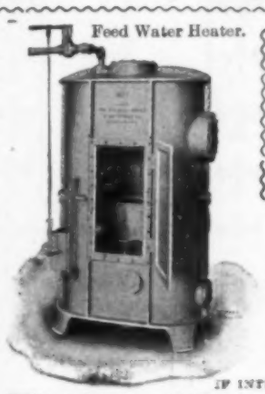

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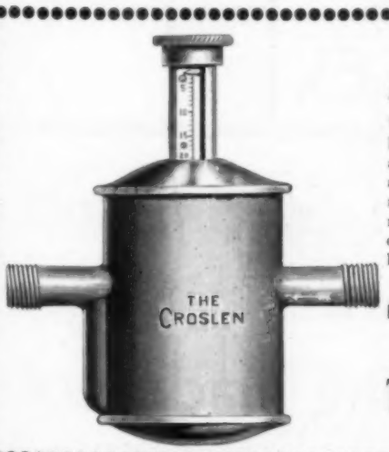

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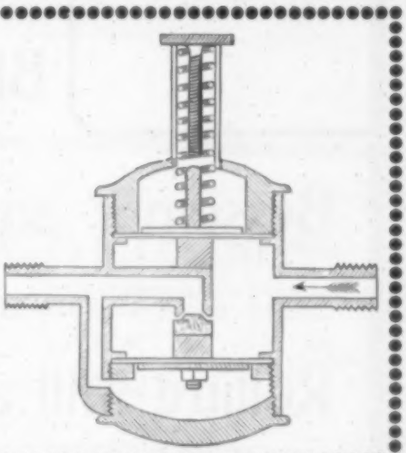

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We have designed and built complete steel works, together with equipment, ranging in capacity from the great Open-Hearth Steel Plant of the Tennessee Coal, Iron & R. R. Co. at Ensley, Ala., containing ten 50-ton Open-Hearth Steel Melting Furnaces and Rolling Mills, to the small steel casting plant of the A. & P. Dutcher Co. at Milwaukee, Wis., with its one 3-ton melting furnace.

The **Wellman Patented Rolling Melting Furnace,** of which we are the sole manufacturers, is now being adopted as the leading type of steel melting furnace, and is being constructed of capacities ranging from three to one hundred tons per heat. A special feature of these furnaces is the forehearth, which gives the melter much greater control over the bath and permits of the contents of the furnace being disposed of in much less time than where the metal must be transferred to pouring ladles. Fifty-five of the Wellman Rolling Open-Hearth Steel Melting Furnaces are now in use or under construction.

The **Wellman Patented Charging Machines and Apparatus** have been so extensively illustrated and described in the technical press and have been so extensively adopted by steel works everywhere that but little need be said of their superiority.

We are the exclusive manufacturers in the United States and Canada of the **Fraser-Talbot Mechanical Gas Producer,** and are constructing and installing complete mechanically-operated gas producer plants of the latest and most improved designs and are prepared to guarantee for such plants a minimum capacity for thoroughly and efficiently gasifying coal, and the maximum amount of labor required to operate the same.

In addition to strictly mill buildings, our work embraces large manufacturing and office buildings, designed for special purposes, bridge work and general structural engineering. The modern machine shop of the American Ship Building Co. at South Chicago was designed by us, as was also the Caxton Building of Cleveland, Ohio.

Besides building a general line of **Standard Overhead Traveling Cranes,** we are giving special attention to designing and constructing cranes for special requirements, such as gantry cranes, cantilever cranes, special cranes for pipe works, shipyards, etc.

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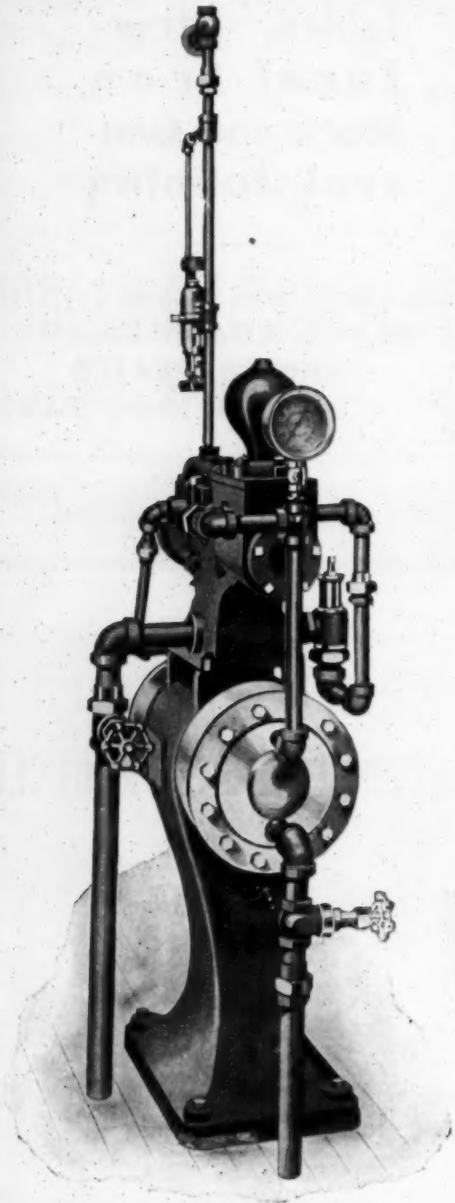

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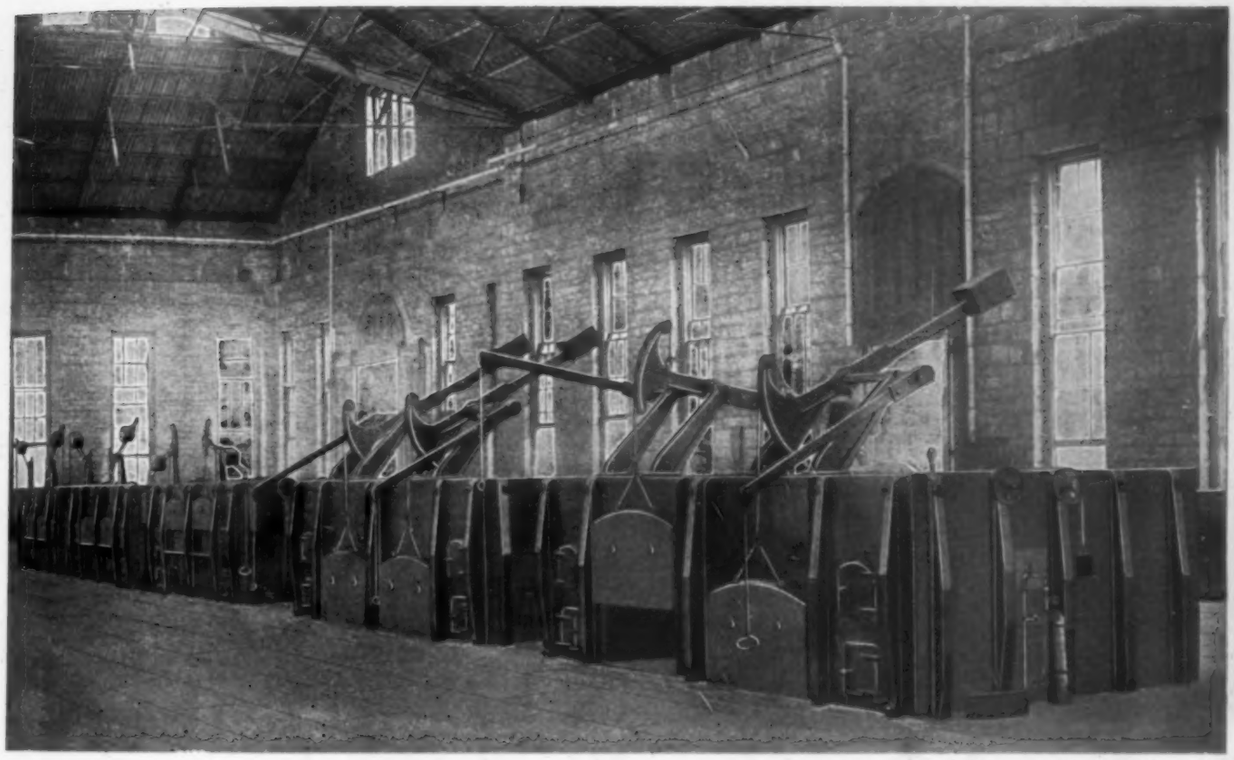

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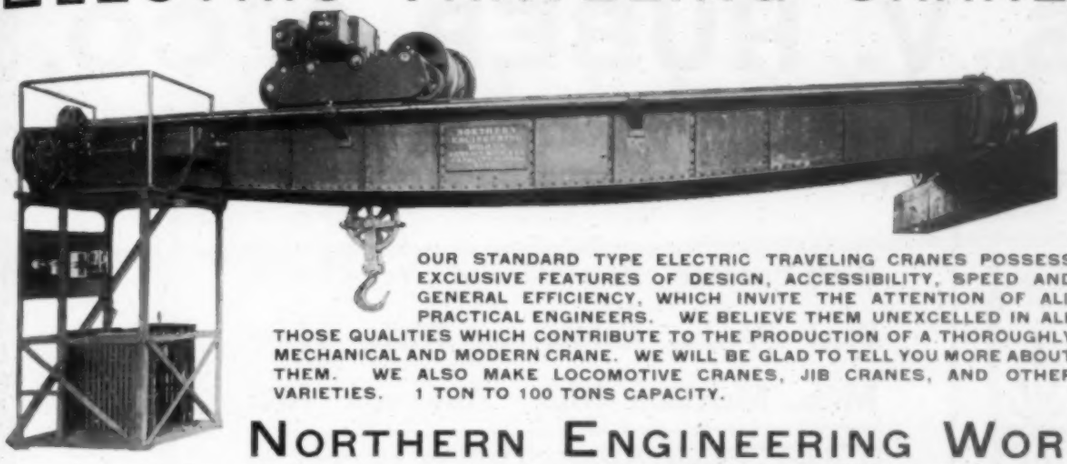

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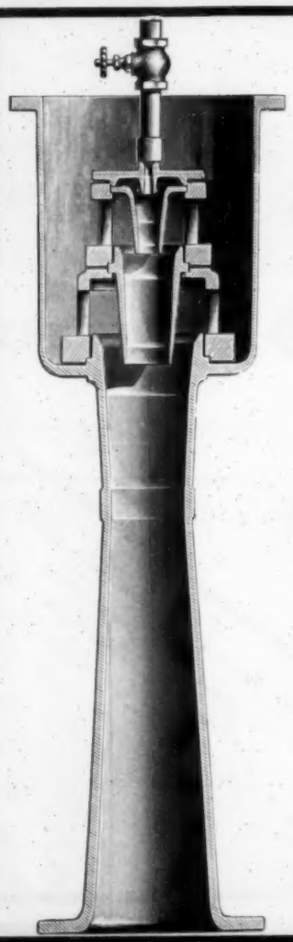

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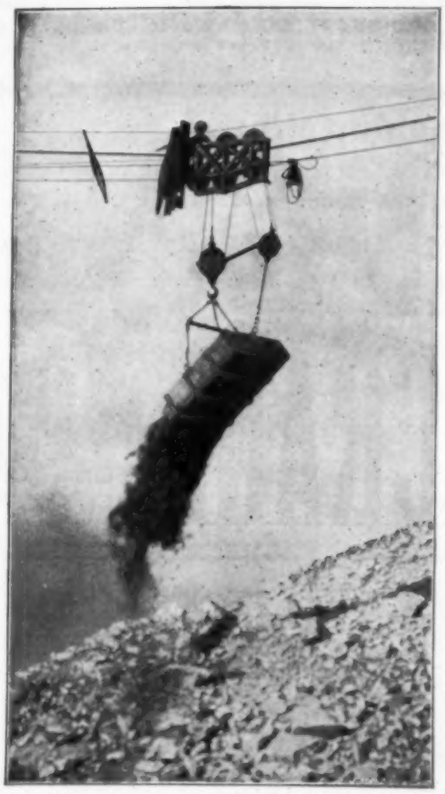

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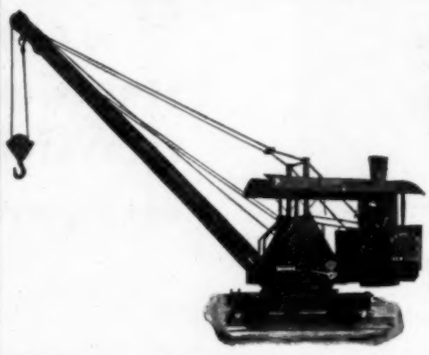

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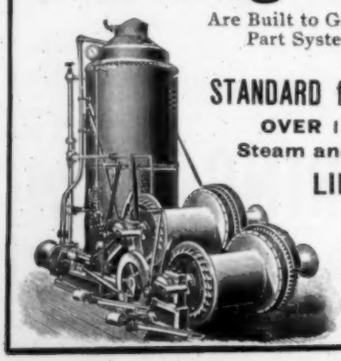

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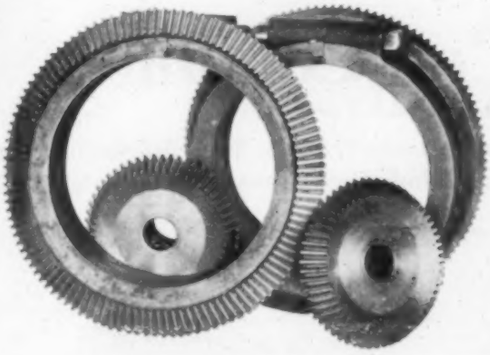

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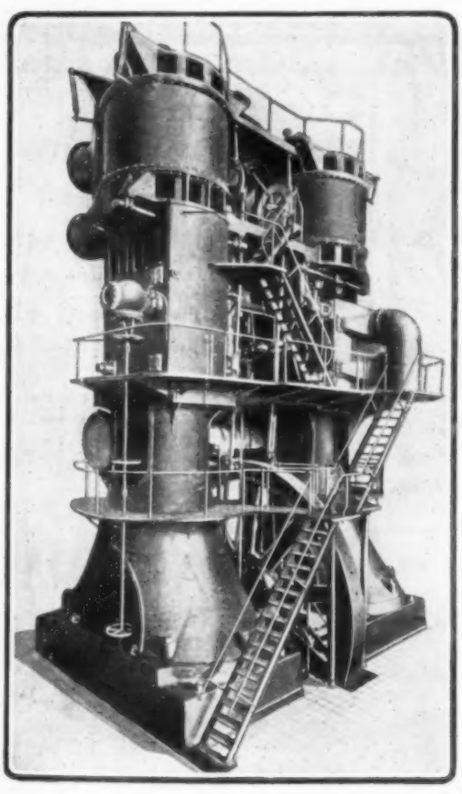

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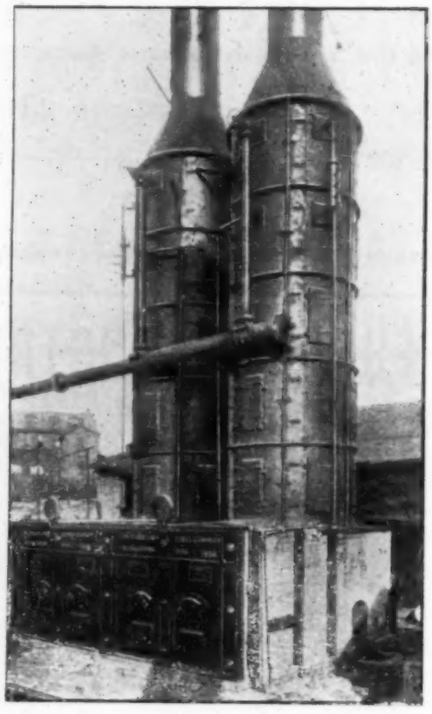

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OUR FIELD

The World.

OUR PRODUCT

Blast Furnaces and Steel Works.
Tanks—Oil, Water, Grain, Coal.
Gas Works, Gas Holders, Retort and Purifying Houses.
Buildings—Mill, Foundry and Factory.
Steel Stacks—Self Supporting.
Riveted Steel Pipe and Penstocks.
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OUR WORKS

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MECHANICAL
ENGINEER,

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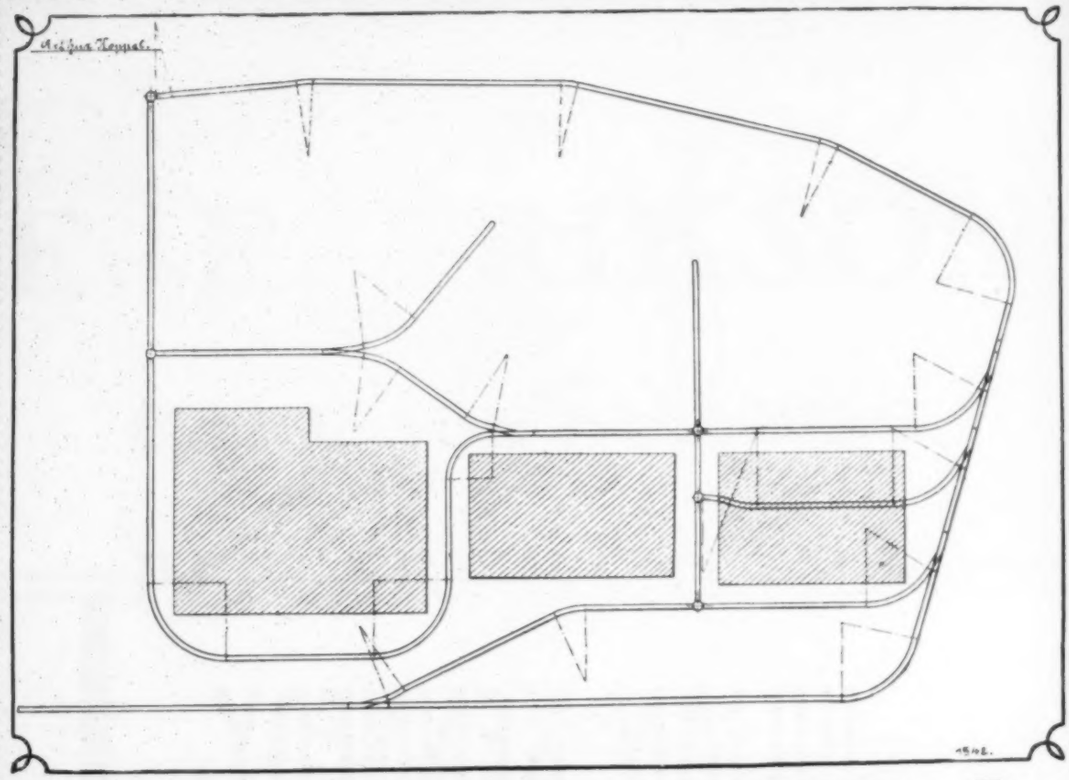

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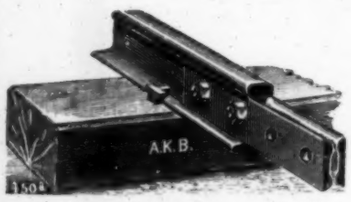
Designed and Equipped by ARTHUR KOPPEL, New York.



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and all accessories.

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mounted on steel ties.

Turntables

of all diameters and for all gauges and capacities.

107a.

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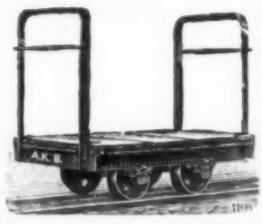

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Platform and Other Cars

for use in and around Factories, Yards, etc.

Contractors' Dump Cars, and Coal Cars for Boiler Rooms Only. Wheels, Axles, Axle Boxes for All Kinds of Cars.

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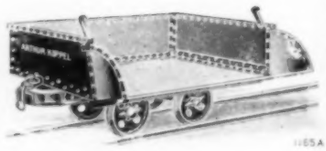
LIGHT RAILS, SWITCHES, FROGS AND CARS ALWAYS IN STOCK.



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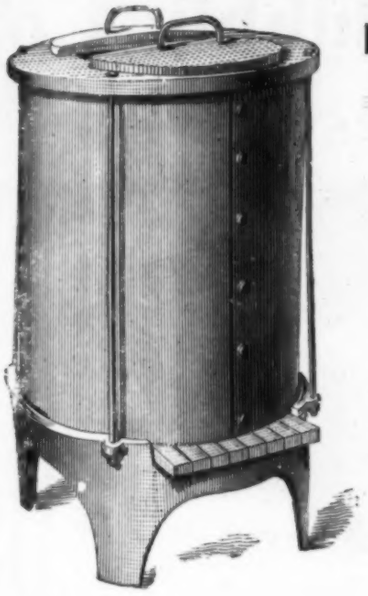
FOR BRASS FOUNDRIES



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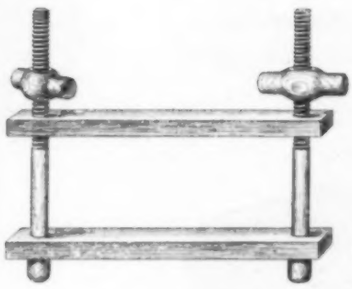
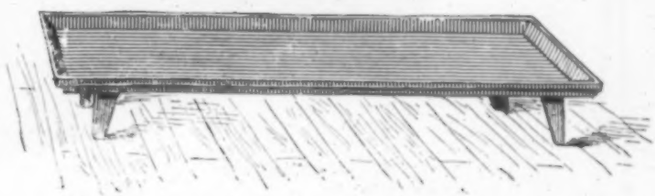


ALL FLASKS ARE GUARANTEED INTERCHANGEABLE WITH ANY OSCAR BARNETT <STANDARD> FLASKS OF SAME SIZE MADE IN THE PAST FIFTY-SIX YEARS.



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Oscar Barnett Foundry Co.

FOUNDED 1845. 58 McWhorter St., NEWARK, N. J., U.S.A.

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Brass Founders' Supply Co.

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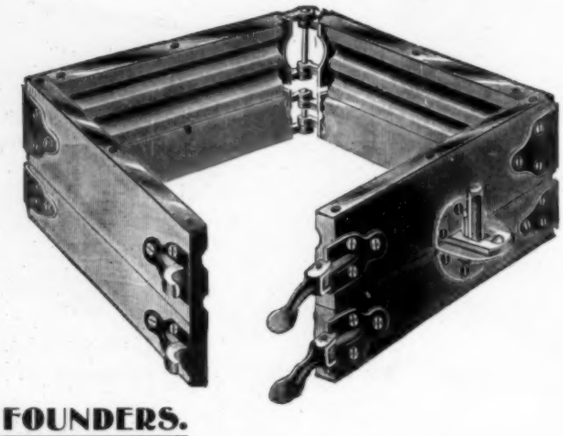

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FOR IRON FOUNDERS.

We have the BEST WOOD FLASKS that are made. All are fitted up so that all the molder has to do is to get down and dig. None of his time need be wasted in making repairs.

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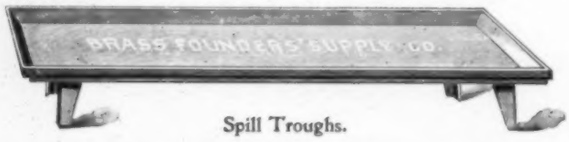

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Cabbage Pots.—For Reducing Scrap Metal to a Ball.

Every appliance necessary for the operation of a successful Brass Foundry.

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KELLY'S LEAD has a national and international reputation for being the best and most reliable.

We are direct importers and manufacturers of Ceylon Leads for all purposes.

Buy where you are sure of getting the goods. We have them in stock all the time and can give you satisfaction if you will permit us.

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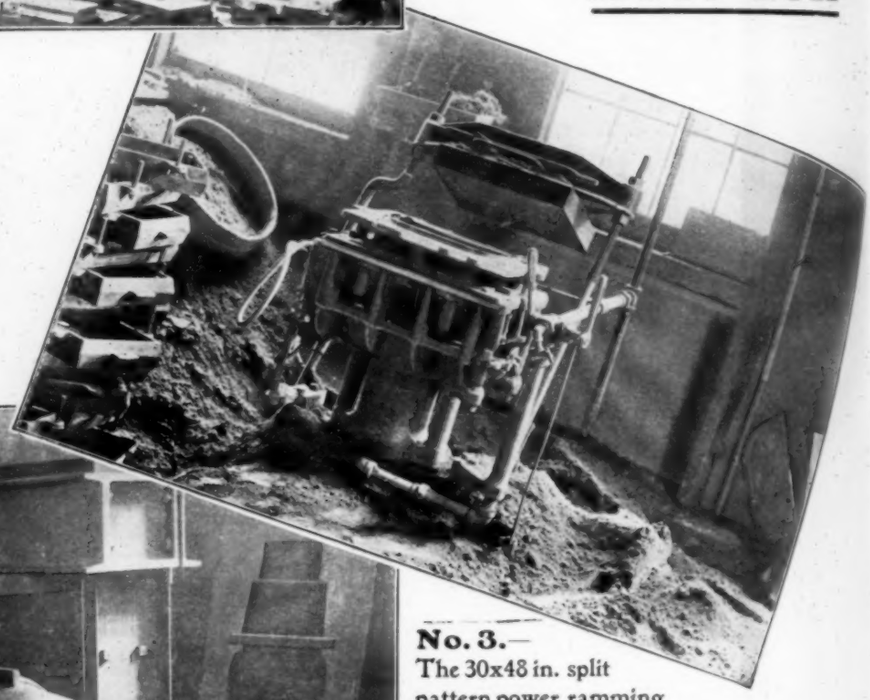
TABOR MOLD

VIEWS OF A FEW OF THE SIXTY. GENERAL ELECTRIC CO.'S FOUN

No. 1. — Showing four Tabor power ramming Vibrator frame machines in the General Electric Co.'s brass foundry.

Machines in best sell



No. 2. — The 13x18 in. split pattern power ramming machine with special stripping plate attachment for 10x20 in. flask.

No. 3. — The 30x48 in. split pattern power ramming machine fitted with a wooden pattern for an oil box cap, weighing 1000 lbs.

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The TABOR MANUF'G CO.

ING MACHINES

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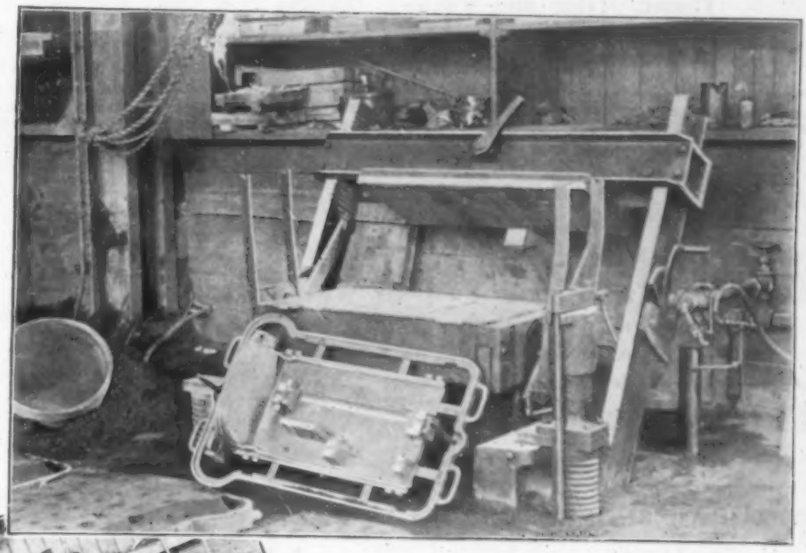
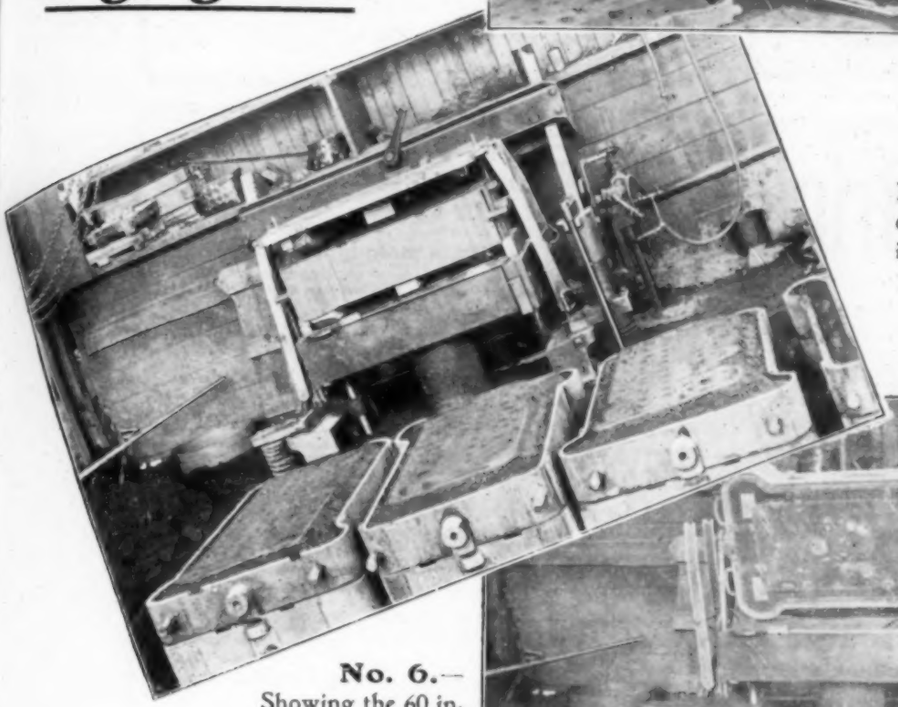
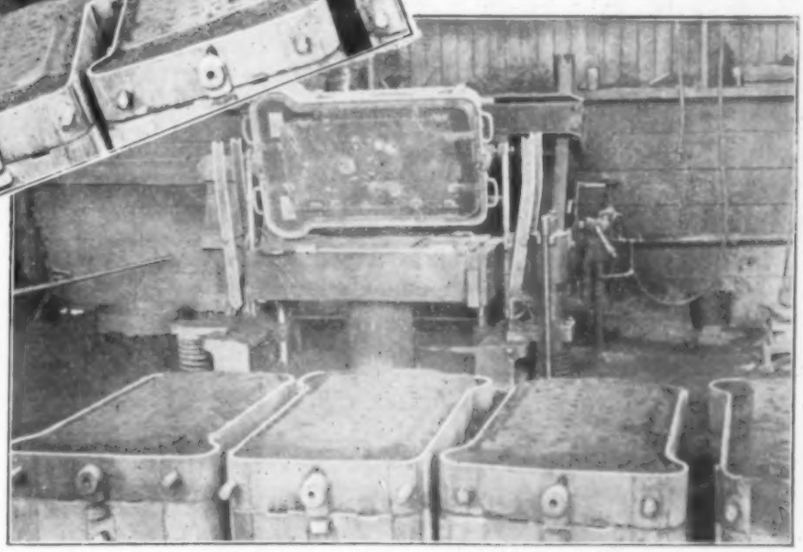


No. 4.—Showing the 60 in. Tabor ramming machine specially fitted with Vibrator frame and attachment for drawing pattern by power.

use are the
ing agents



No. 5.— Showing the 60 in. Tabor machine drawing the pattern.



No. 6.— Showing the 60 in. Tabor machine with roll-over attachment in operation.

Tabor

18th & Hamilton Sts., PHILADELPHIA, PA.

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HEAVY or LIGHT CASTINGS.

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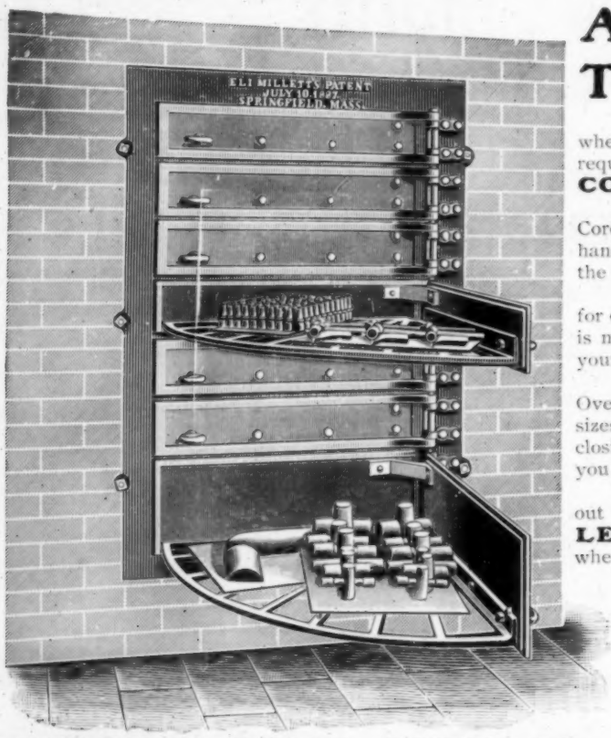

ALL OVER THE WORLD

wherever castings are made and good cores required you will find the **MILLETT CORE OVEN.**

Please remember that nine-tenths of the Cores used are small ones, capable of being handled by hand, and wanted at all hours of the day.

Your present Core Oven may be all right for drying molds and very heavy Cores, but it is not what you want for the greater part of your work.

You have no control over your big Core Oven when it is used for drying the smaller sizes of Cores. With the independent shelf self-closing, continuously working **MILLETT** you have control of everything.

Your Cores will cost you less and be turned out in better shape if you use a **MILLETT.** Coremaking becomes a pleasure wherever this oven is used, and it is a common occurrence to find that it doubles the output from the same men.

See the **MILLETT CORE OVEN** in the show rooms of the S. Obermayer Company, Cincinnati and Chicago, and the J. W. Paxon Co., Philadelphia.

MILLETT CORE OVEN CO., Brightwood, Mass.

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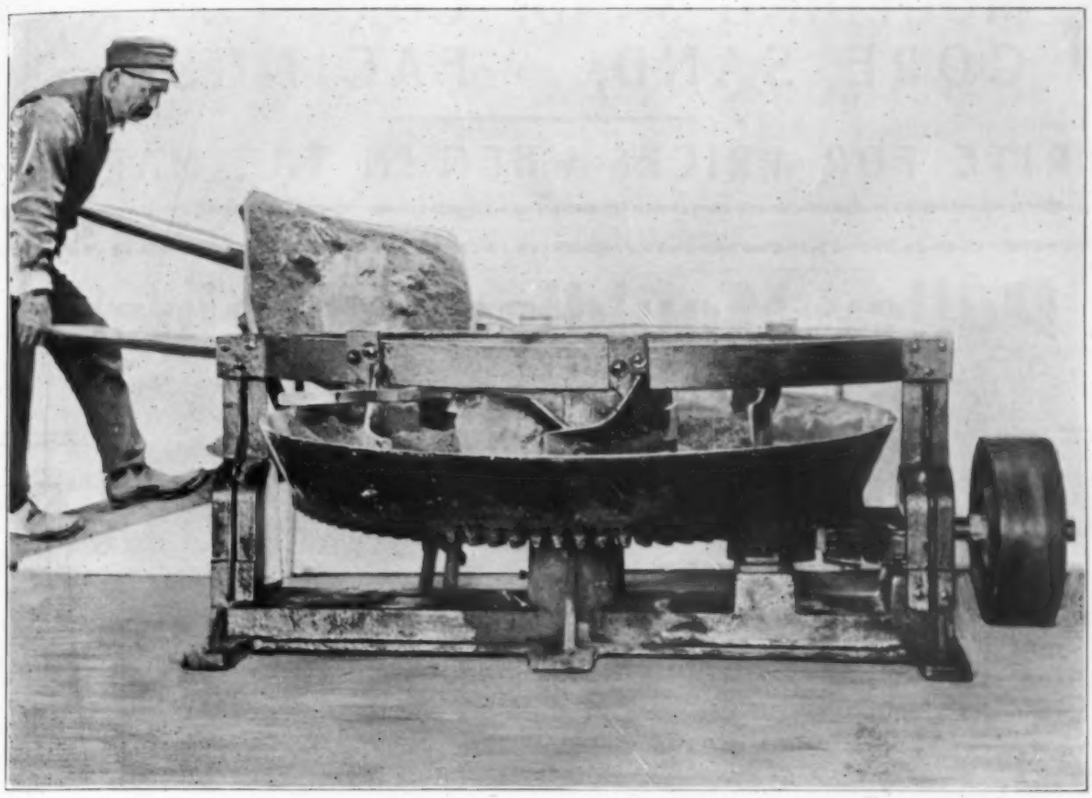
FOR BUILDERS AND CONTRACTORS



THE SLY INCORPORATOR will thoroughly mix or incorporate two wheelbarrow loads of sand and gravel or crushed stone and the required amount of cement, in the most thorough manner possible, and unload the whole charge in one minute. It will continue this performance indefinitely. There is no stoppage of the machine to load or unload. Nothing on the market will compare with it in either quality or quantity of work done.

As a mortar mixer for plasterers, bricklayers or stone-masons it is without a peer. Hand labor will cost several times as much and no machine now in existence will stand a ghost of a show in competition with the SLY INCORPORATOR.

This machine will be mounted on a truck or on skids as desired. A gas or gasoline engine mounted direct on the bedplate will furnish herequired motive power.

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MOULDING SAND, CORE FLOUR,
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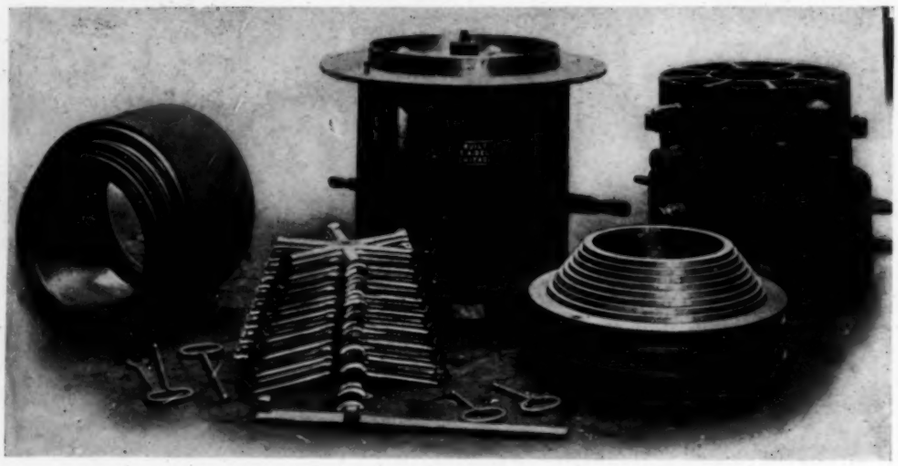
WRITE FOR PRICES WHEN IN THE MARKET.

Pulley Moulding Machinery

Built by E. A. DELANO.



50 to 56 S. Clinton Street, CHICAGO ILL.

THE above cut shows our No. 2 Pulley Moulding Machine, which moulds pulleys from 16 to 24 inches diameter, using 9 rim patterns, 9 sets of inside and outside rings or stripping plates, 3 sets of arm patterns for each diameter, and 2 sample flasks, all of which outfit is shown in the cut, which is a reproduction from a photograph taken of one of these machines just previous to its shipment. We make nine sizes of machines, as follows:

No. 0 Machine, which moulds from 3 to 5¼ inches diameter.	No. 3 Machine, which moulds from 25 to 36 inches diameter.	No. 6 Machine, which moulds from 63 to 72 inches diameter.
No. 1 " " " " 6 to 15½ " "	No. 4 " " " " 37 to 48 " "	No. 5½ " " " " 37 to 60 " "
No. 2 " " " " 16 to 24½ " "	No. 5 " " " " 50 to 60 " "	No. 6½ " " " " 50 to 72 " "

A few of the representative firms using these machines are as follows:

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Lane Mfg. Co., Montpelier, Vt.
Baush Machine Tool Co., Springfield, Mass.
Woonsocket Machine & Press Co., Woonsocket, R.I.
Pratt & Whitney, Hartford, Conn.
Crowell Clutch & Pulley Co., Westfield, N. Y.
Meese & Gottfried, San Francisco, Cal.
Wheland's Machine Works, Chattanooga, Tenn.
H. N. Strait Mfg. Co., Kansas City, Kan.
Link Belt Machinery Co., Chicago, Ill.
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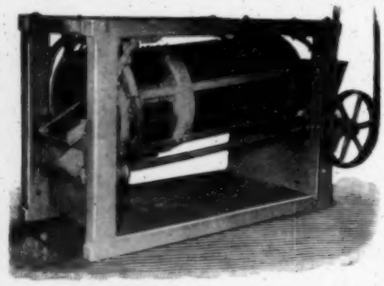
Samuel C. Tatum, Cincinnati, Ohio,
Pyott Foundry Co., Chicago, Ill.
Continental Gin Co., Birmingham, Ala.

All users of these machines agree that they are profit makers. Are you interested?



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EVERY FOUNDRY NEEDS ONE.

SAVES IRON AND SAVES POWER.

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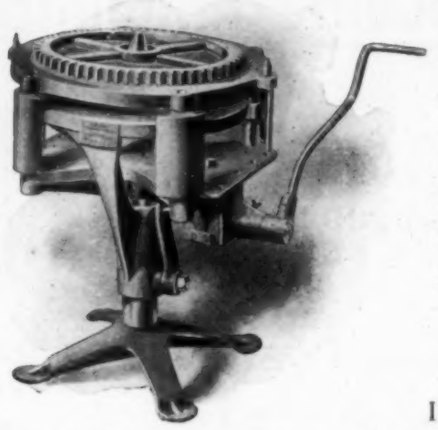
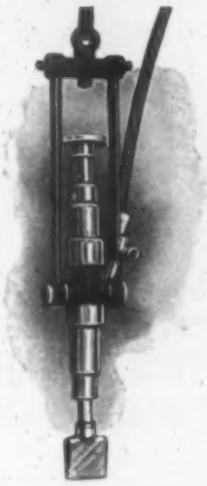


The Maywood Molding Machine

Will reduce the cost of your castings and improve their quality. Remember that we do not attempt to make your casting fit OUR MACHINE, but build it to suit YOUR JOB. Every molding machine is thoroughly tested in our own foundry before it leaves here, and when you put a **Maywood** in your foundry you may be sure that it will do its work right.

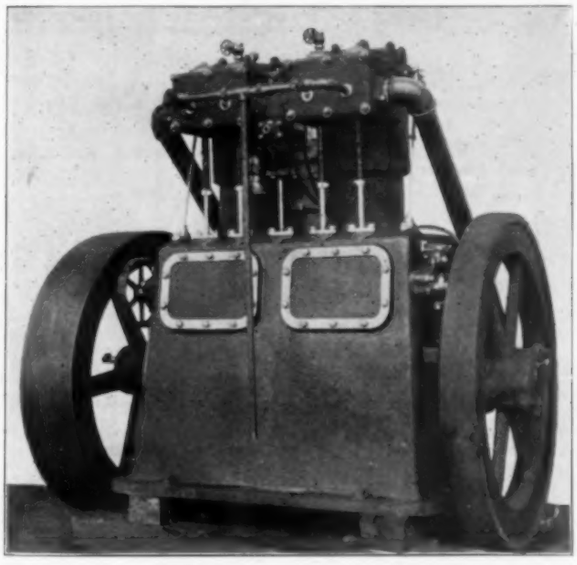
The Maywood Pneumatic Rammer



Is made in various designs and sizes to suit different conditions. It is the only practical sand pounder on the market, and you will find it to your advantage to try it. One man will do as much work as half a dozen, and do it better. For ramming up loam pits and large molds it is to the foundry what the steam hammer is to the blacksmith shop, and the saving it effects is even greater.

The Maywood Gas Engine

Is eminently THE engine for manufacturing establishments of all kinds.



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General Foundry Work.

The capacity of our foundry is greater than needed for our own requirements, and if you are in want of first class gray iron castings, we will consider it a pleasure to furnish you quotations on receipt of sample casting or patterns.

Write us wherein we can help you. We will give your correspondence prompt attention. ∴ ∴ ∴ ∴

MAYWOOD FOUNDRY & MACHINE CO.

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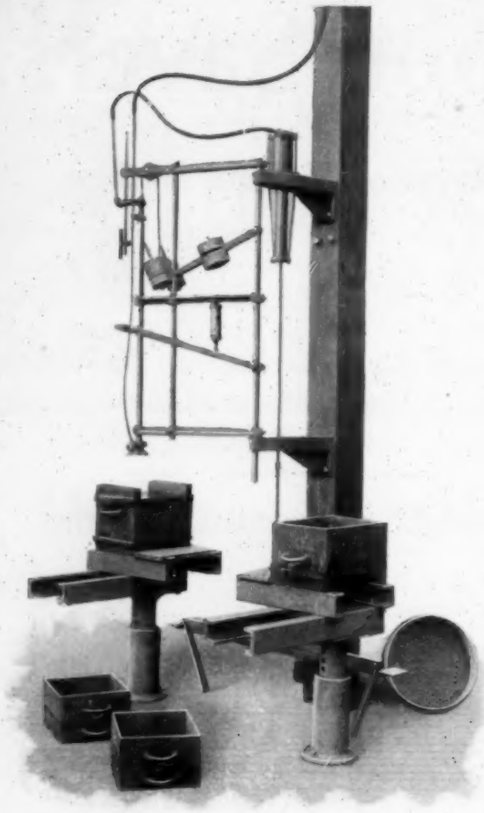

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FOR USE WITH WOOD PATTERNS.

Reduces Cost of Moulding 50 Per Cent. . . .

Does away with expensive metal Patterns and Stripping Plates.

Made with Foot-power Vacuum Pump or arranged to connect to Central Vacuum Plant.

Designed for any Service.

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Molding Machines

14-in. x 16-in. Split Pattern Machine.

LOWEST POSSIBLE PATTERN COST.

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SUITED TO ALL CONDITIONS.

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2. Vibratory Machines, no Stripping Plates.

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Maple Mallets.
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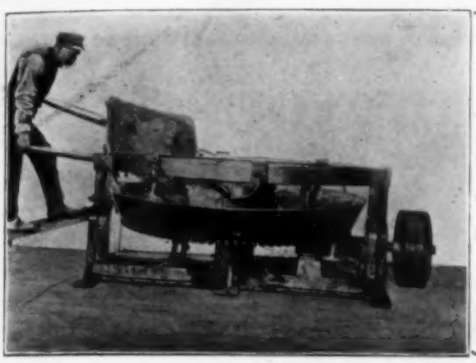

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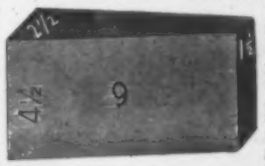

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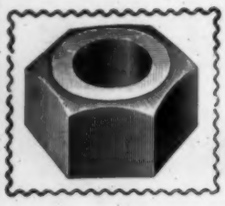

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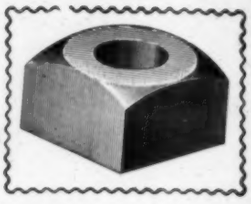

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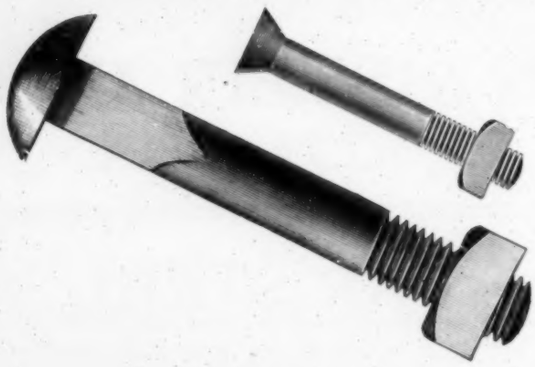

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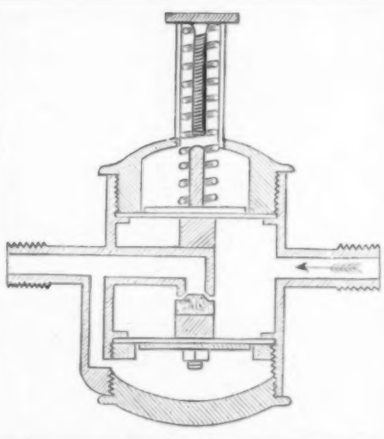

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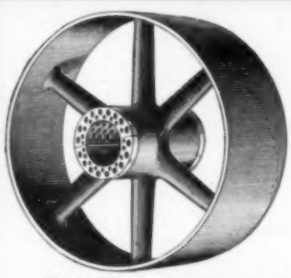

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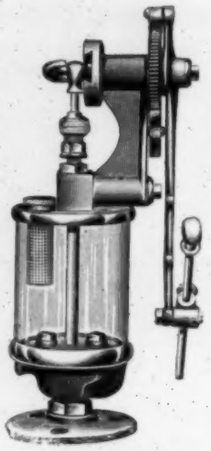

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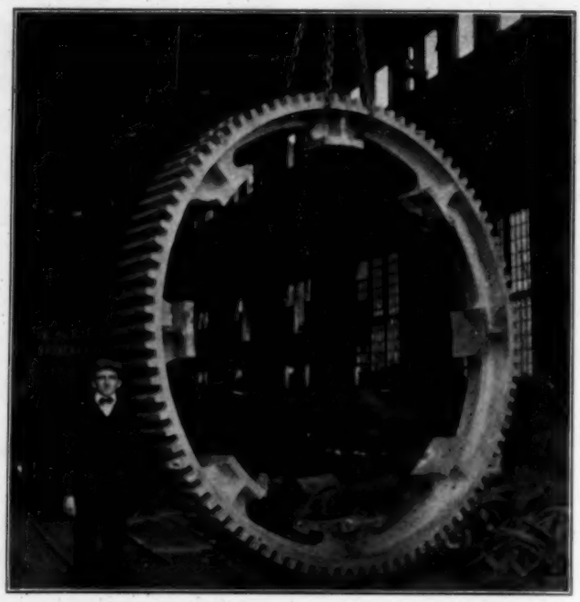

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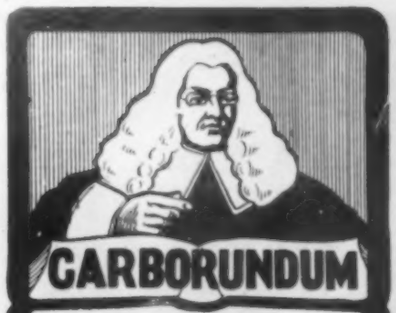

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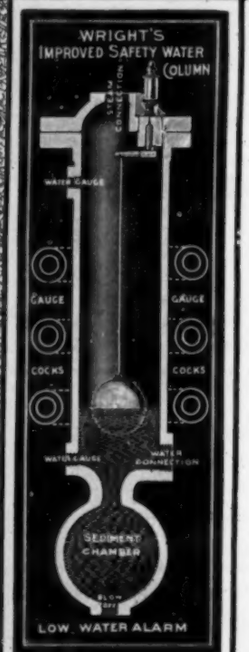

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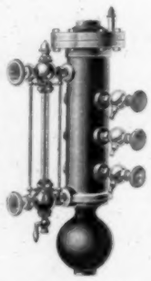

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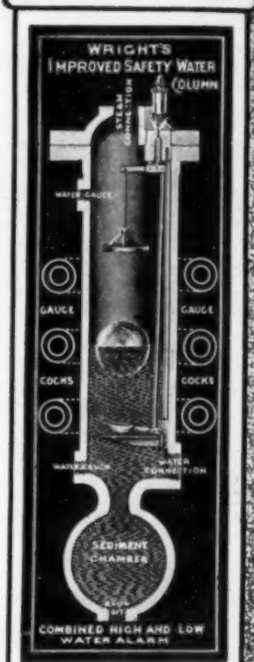

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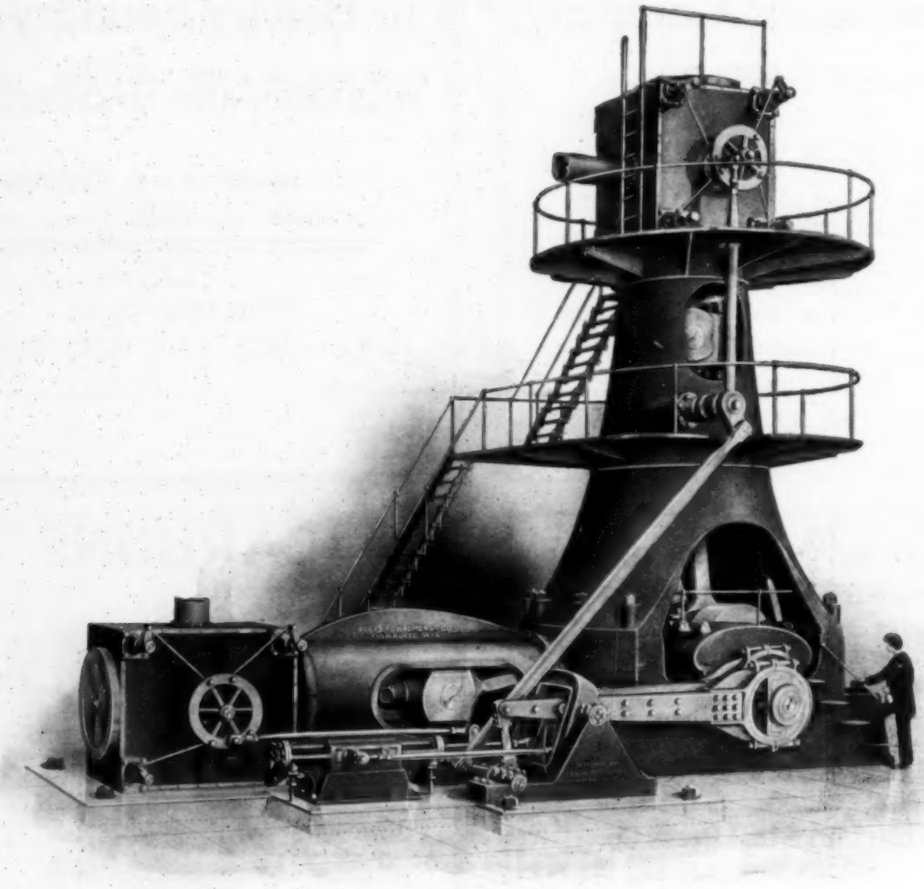

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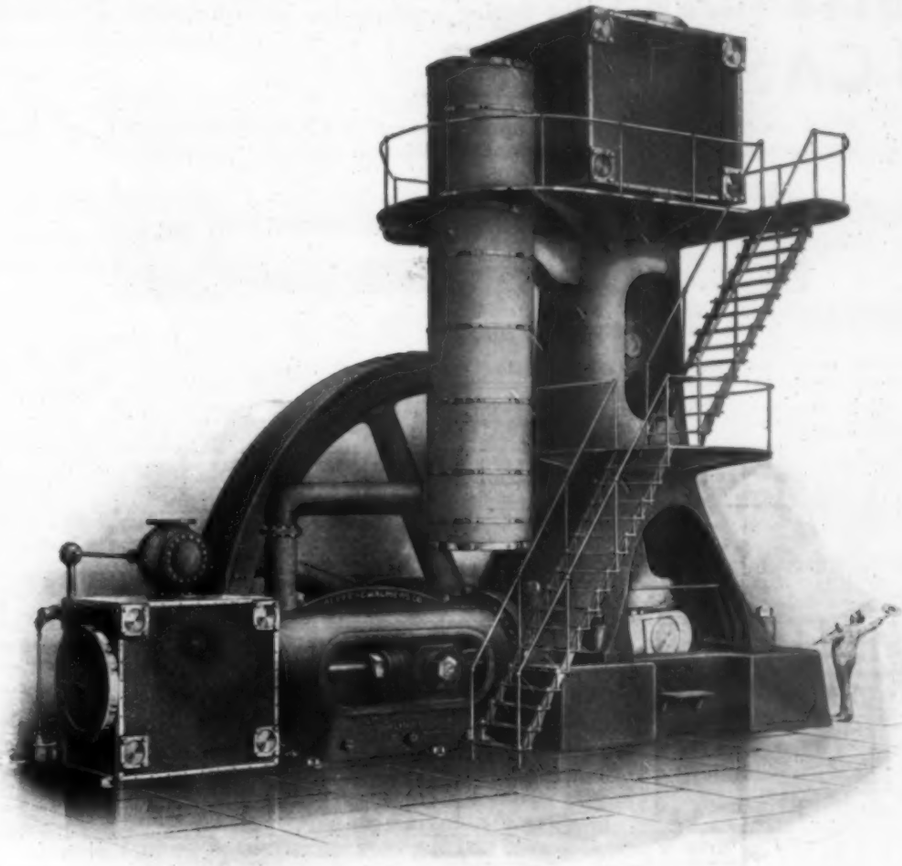

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Marked.	Size in inches.	Area in sq. inches.	Elastic limit in lbs.	Elastic limit per sq. inch in lbs.	Ultimate strain in lbs.	Ultimate strain per sq. inch in lbs.	Elongation in 8 inches.	Elongation per cent. of length.	Size of reduced section in inches.	Area of reduced section in sq. inches.	Per cent. of reduction.
Plain.	.703 diam.	.4939	13,550	27,430	36,000	72,890	1.34	16.75	.723 diam.	.4105	16.89
Treated.	.796 "	.4976	26,200	52,650	42,000	84,410	1.47	18.38	.626 "	.3078	38.14

American Steel Casting Co.'s Cast Steel.

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Per LOUIS R. SHELLENBERGER, Engineer of Tests.

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LABORATORY NO. OF TEST 15168-9.
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We have this day tested for you two specimens of Cast Steel subjected to transverse strain and beg to submit the following report:

Marked.	Size in Inches.	Area in sq. inches	Load.	Deflec.	Set.	Load.	Deflec.	Set.	Remarks.
2. Plain.	1.015 x .915	.9287	500	.001	.000	2500	.048	.019	100 lbs. taken as zero point for all readings in these tests.
			1000	.014	.001	3000	.150	.103	
			1500	.022	.003	3500	.322	.279	
			2000	.031	.000	.....	.500	.450	
2. Treated.	1.031 x .996	1.0269	500	.000	.000	3500	.040	.002	
			1000	.010	.000	4000	.051	.007	
			1500	.016	.000	4500	.063	.017	
			2000	.021	.001	5000	.186	.130	
			2500	.026	.001	5500	.317	.251	
			3000	.032	.001	6000	.500	.425	

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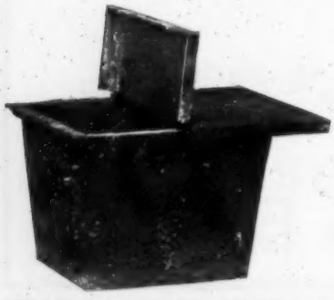

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TIME SCHEDULE.

Southbound, (down). (up). Northbound.
June 9th, 1901.

15	13	11	Lorain Branch	10	14	16
P.M.	P.M.	A.M.		P.M.	A.M.	P.M.
6:00	1:05	6:30	Lorain	3:25	11:15	7:55
6:16	1:25	6:44	Elyria.....	3:13	11:00	7:41
6:33	1:43	7:01	Grafton	2:56	10:45	7:23
6:53	2:15	7:20	Lester Jun....	2:35	10:23	7:05

Main Line.

Southbound	7	5	3	1
	A.M.	P.M.	P.M.	A.M.
Cleveland.....		5:55	1:35	7:20
Brooklyn.....		6:11	1:49	7:34
Lester.....		7:03	2:31	8:21
Medina		7:15	2:40	8:30
C. Lake.....		7:27	2:51	8:41
Seville		7:37	2:59	8:50
Sterling		7:45	3:04	8:56
Warwick.....		8:07	3:24	9:16
Canal Fulton		8:15	3:32	9:23
Massillon.....	6:30	8:35	3:50	9:43
Justus.....	6:49	8:51	4:06	9:59
Canal Dover	7:21	9:30	4:37	10:30
New Phila.....	7:28	9:37	4:44	10:37
Uhrichsville	7:43	9:45	5:01	10:55
Flushing	8:52		6:07	12:05
Bridgeport.....	10:00		7:05	1:05

Northbound.	2	4	6	8
	A.M.	A.M	P.M.	P.M.
Cleveland	8:30	11:15	6:00	
Brooklyn,.....	8:13	11:1 1	5:46	
Lester.....	7:27	10:22	5:00	
Medina	7:15	10:14	4:48	
C. Lake.....	7:02	10:04	4:35	
Seville.....	6:52	9:56	4:26	
Sterling.....	6:46	9:50	4:20	
Warwick.....	6:25	9:30	3:56	
Canal Fulton	6:18	9:23	3:48	
Massillon.....	6:00	9:05	3:30	7:50
Justus	5:45	8:50	3:13	7:34
Canal Dover.....	5:15	8:20	2:44	7:03
New Phila.....	5:08	8:13	2:37	6:55
Uhrichsville	4:50	7:53	2:20	6:38
Flushing.....		6:57	1:20	5:34
Bridgeport.....		6:00	12:20	4:30

Sunday trains at Cleveland depart 7:20 a. m., 5:55 p. m.; arrive 9:50 a. m., 6 p. m.

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Depot foot of So. Water St. City Office 241 Superior St.	Depart.	Arrive.
Akron, Canton, & Valley Jct....	*7:15 A M	*6:20 P M
Akron, Canton, & Marietta.....	†11:00 A M	†2:10 P M
Akron, Canton, Valley Jct.....	*3:25 P M	*9:25 P M
Akron, Canton.....	*6:30 P M	*10:00 A M
Akron, Canton.....	*11:20 P M	*8:10 A M
Baltimore & Ohio R. R.		
Chicago { and all intermediate stations }	†7:15 A M / *6:30 P M	†9:25 P M / *8:10 A M
New York { Pitts'gh, Wash. / Balt're,, Phil'a. }	*3:00 P M / *11:20 P M	*10:45 A M / *9:25 P M

† Daily except Sunday. * Daily. Pullman's Palace Vestibule sleeping cars between Cleveland and Chicago; also Washington, Baltimore, and Philadelphia

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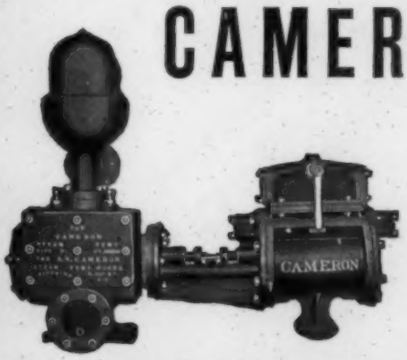

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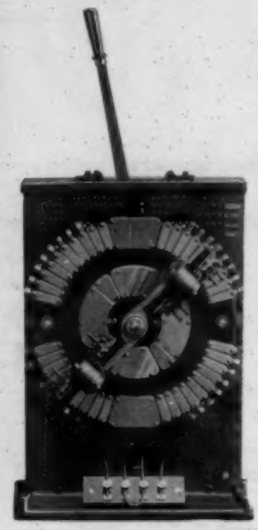

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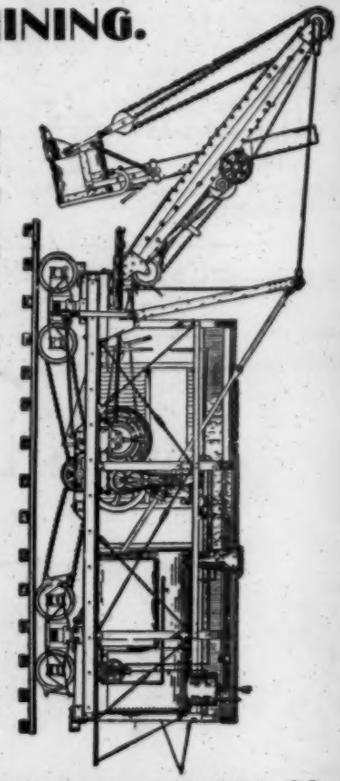

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